THE COMMUNICATIVE ACCOMPLISHMENT OF KNOWLEDGE WORK IN THE CONSTRUCTION INDUSTRY

A Dissertation

by

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Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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May 2016

Major Subject: Communication

ABSTRACT

The domestic construction industry consists of project based, dispersed organizations that face unique challenges when compared to other sectors. These challenges have largely slowed the innovative capacity of the industry. Knowledge management is a communicative practice that moves beyond data and information management systems approaches to engage the largely tacit know-how and expertise of organizational members and project stakeholders. This study attempts to further the understanding of the communicative accomplishment of knowledge work in the construction industry by engaging in both ethnographic and survey data analysis to help determine (1) how organizational members communicate what they know with others to solve problems and create capacities for action in our everyday work practice; (2) the level of knowledge management use among domestic construction organizations; (3) what motivates organizations to adopt new knowledge management practices; and (4) whether communicative knowledge management practice had measurable benefits to the organizations who were attempting to implement it.

The first study is an ethnographic investigation of the communicative practice that one construction company utilized to help manage its knowledge resources. Everyday knowledge management practices observed included the use of structured occasions and planning meetings where project stakeholders engaged in the use of questioning and mentoring in a way that promoted an organizational learning culture which relied on a

complex and largely unregulated network of expertise. The findings also suggest that embodied knowledge should be considered to help explain how organization actors approach problem solving episodes. Lastly, the study highlights the possibility of an organizational transactive memory system that helps organizational members know who knows what.

The second quantitative study takes stock of the current levels of knowledge management practice among a sample of domestic construction companies. The study found that knowledge management systems were still relatively rare, despite the uniform belief in their value and importance. The motivation to adopt knowledge management practices was shown to indirectly increase project benefits, being mediated by both the obstacles to knowledge management adoption and specific knowledge management tool use. Theoretical and practical implications are discussed in regard to each study, as well as the research project as a whole.

ACKNOWLEDGEMENTS

First, I would like to thank my advisor, Dr. Joshua B. Barbour, for all of his support and encouragement throughout this project. His inspiration and guidance can not be overstated. My committee members Dr. J. Kevin Barge, Dr. Charles R. Conrad, and Dr. Dudley L. Poston Jr. must also be thanked for their valuable feedback and important contributions in this constructive process. I also extend my gratitude to the other faculty, staff and students in the Department of Communication at Texas A&M University for creating a respectful, engaging and challenging learning environment that I sincerely enjoyed working in. Thank you also to the Department of Communication and the College of Liberal Arts at Texas A&M University for the generous funding that made this research possible.

This research would not have been be possible without the help of those in the construction industry. Thank you to the organization and its members who allowed me access to their work lives, and to the construction leaders who responded to my survey.

Lastly, I must thank my family who has stood by me throughout this grand experience. Thank you to my parents, Carl and Marianne Sommer. I am forever in their debt for their selfless encouragement and support. And the biggest thank you to my wife, Elizabeth Sommer, who has been the best supporter of all. I could not imagine having accomplished this without her. I must thank her for knowing what I needed, even when I didn't, and for being my constant companion and source of encouragement.

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CHAPTER I

INTRODUCTION TO THE CONSTRUCTION INDUSTRY, KNOWLEDGE AND WHY IT MATTERS

Introduction

As of September 1st, the Census Bureau of the United States Department of Commerce estimated that the seasonably adjusted annual rate of the value of construction put in place for 2015 was almost $1.1 billion, up over 14 percent from the September figures of 2014 (Census Bureau, 2015). A report published by Global Construction Perspectives and Oxford Economics estimated that global construction output will grow by more than 70% to a staggering $15 trillion by 2025, a projection that outpaces global GDP (Global Construction, 2013). This growth is concentrated in China, the United States, and India, and the American Society of Civil Engineers (ASCE) estimates that an investment of $3.6 *trillion* will be needed by the year 2020 simply to maintain U.S. infrastructure. For example, 42% of America's urban highways are congested at a cost of over $100 billion annually to the American public in time and fuel, and the Federal Highway Administration estimates $170 billion in annual investments are needed to improve the highway infrastructure and raise the current ASCE grade from a D (ASCE, 2013). The American construction industry plays a major role in our country's GDP and daily experience as we rely on their products, processes, and expertise to keep us working and playing every day.

At the same time, the industry is hammered by fragmentation and weak innovative capabilities, especially compared to other growing industries like

manufacturing (Drejer & Vinding, 2006; Dubois & Gadde, 2002). As a result of this fragmentation and other unique challenges that will be highlighted shortly, the construction industry is known for not meeting clients needs (Barlow, 2000), being over-budget, and behind schedule (Emmitt & Gorse, 2006). Styhre (2009) recognized that innovation in the construction industry is needed, and that innovation depends on effective knowledge management (KM):

> The construction industry is in great need of optimizing the use of its intellectual resources. In addition, since the built environment is what strongly influences everyday work-life in contemporary society, and the cost of living and housing accounts for a substantial part of the private and public economy, the ability to exploit existing bodies of know-how more effectively is a widely desirable objective. (p. 7)

Kazi (2005) argued that the global construction industry is beginning to realize the benefits of developing and harnessing the communicative accomplishment of knowledge work: "The construction industry in general is realizing that a tool on its own is not enough. There is a need to instill a knowledge-sharing culture within the organization that fosters social communication and interaction" (p. 23). Knowledge is a social phenomenon, and our ability to manage that knowledge relies on our communication (Kuhn & Jackson, 2008; Styhre, 2009;). As a result, this research project is oriented around the investigation and support of the communicative accomplishment of knowledge work as it pertains to the domestic construction industry. Realizing the need, however, and competently doing something about it, are two different matters. The

nature of the construction industry involves inherent challenges including the novelty of each project, geographic dispersion, conflicts of expertise, and time and fragmentation issues that have prevented or slowed the industry's ability to engage in new and innovative knowledge management practice.

Challenges of the Construction Industry

Novelty. Each project brings with it unique challenges and problems (Kazi, 2005). Moving from one project to the next, project members will rarely work with the same group of managers, contractors, skilled laborers, operators, and suppliers. Therefore, information cannot simply be transplanted from one project to the next—it requires the interpretation and action of the individual, given the particular context and environment (Styhre, 2009). Emmitt and Gorse (2006) have describe this situation:

> In the vast majority of construction projects, the participants are brought together to work on one project only. On completion of the project, or more accurately on completion of a participant's particular work package, the relationship between the individual and the project stops. This means that, with the exception of large and repetitive projects, it is not uncommon for the project team to be composed of actors different to the previous one. This is often true even where the same organisations are involved, simply because different individuals within the organisation have been assigned to the project according to internal workload commitments. (p. 30)

With such novelty comes novel problems. But similar types of problems must be experienced from one project to the next. The challenge in that situation then resides in the ability of the individual or team to utilize the know-how of their network of experts

to help them solve a problem without the need to completely reinvent the wheel. At the same time, the "wheel" can't be used in every situation in the same way (Fong & Wong, 2005), so it must be communicated and interpreted according to the situation and context (Bartholomew, 2009). As a result, useful practices can't consist of specific solutions or outcomes, but instead must include problem solving capabilities that rely on the communicative nature of know-how and the embodied expertise of the construction craft (Sennett, 2008).

Geographic dispersion. Not only are project based organizations relying on tacit (individual, learned experience that is difficult to share and demonstrate) knowledge to complete their projects on time and within budget, but they're also geographically dispersed. Project managers, skilled laborers, business owners, and other various employees may be scattered across a region, a country, or the globe. The communicative activities that these organizational members utilize must allow for the dispersed nature of the organization (Sole & Edmondson, 2002). Brown and Duguid (2002) argued that location matters. Even though information technology was predicted to vanquish co-located firms, practices, and practitioners, we still see the development of places like Silicone Valley and the Research Triangle:

> Information technology is very good at reach, it is less good at the sort of dense reciprocity needed to make and maintain such strong and informative informal links. And it is these informal links running along networks of practice that allow knowledge to flow to where, from an ecological perspective, it belongs. So distance

> is far from dead, even where distance technology is at its most advanced. (Brown & Duguid, 2002, p. 169)

The situated nature of KM among communities of practice which identify uniquely by site or location, such as those in construction organizations who are geographically bound, is a barrier to knowledge sharing and implementation. As the context (shared enterprise, mutual agreement, and shared repertoire) changes, so to does the nature of the knowledge and its applicability (Sole & Edmondson, 2002). According to Zorn and Taylor (2004), "KM is in part a response to problems created by globalized, networked organizations, including the problem of distributed expertise...In many cases, workers need to coordinate their efforts with each other, or draw on expertise that may not be easily accessible" (p. 101). So not only are there unique challenges to address during the project life cycle, but many times, the knowledge resources needed to help solve those situated problems is spread across a large geographic area. Once those challenges have been overcome, there's still an issue of determining what the best course of action may be, given the variety of exerts that could be consulted in a given episode.

Conflict of expertise. The nature of tacit knowledge, expressed through the expertise in practice on the jobsite, provides opportunity for conflict and disagreement about the 'right' way to do something. Drawing upon the same information, different project members can come to different conclusions based on their tacit knowledge, which they then must attempt to articulate in order to support their solution. Here issues of leadership may become apparent as the formal hierarchy is often relied upon to settle disputes (e.g. the engineer or architect says so...even if they lack the tacit knowledge that

a contractor holds which informs him that the solution isn't the most optimal). Rooke and Clark (2005) discovered this very tension as they concluded that the lived, experiential knowledge of a site worker often clashed with the theoretical, school taught knowledge of engineers. When that experiential knowledge is ignored, safety improvements pushed by engineers were coopted or outright rejected on the basis of personal experience and know-how (Rooke & Clark, 2005). Poor communication between production and design sectors of a project can easily lead to a barrier for learning, and subsequent KM, as designers lack important feedback that would be useful for future designs (e.g. don't use this material because it doesn't install properly, which can compromise the final product). As a result of this breakdown in communication, the production side also misses useful explanations to certain design or product choices that would help their understanding of project goals and customer needs (Styhre, Josephson, & Knauseder, 2004).

Knowledge claims also function as identity work (Alvesson, 2001), meaning that as actors attempt to manage their expert or professional identity, those identities and knowledge claims will often be questioned explicitly or figuratively as they engage in their work. Sennett (2008) identified a common intellectual and social separation between what he called "the head and the hand," (p. 45). The head refers to the architectural, conceptual, engineering and design work that takes place among the elite knowledge working class who then transfer the information to the craft, or the hand, who is responsible for the the physical construction process. The head often doesn't involve the hand when considering their work, and as a result, the two are both socially and

intellectually separated, even though each needs the other to produce a product for the customer. Overcoming this obstacle means breaking down the barriers, both physical and social, that prevent the two from working together throughout the project.

Time pressures and fragmentation of the industry. Time plays a major role for practitioners who want to improve their practice, as there is little of it to direct towards better management of anything in such a fast paced industry (Fong, 2005). Because so many different organizations, skills, and knowledge levels must coordinate in order to complete a project, it becomes very difficult to maintain an understanding of who knows what, and when to seek out information or knowledge resources or tackle a problem alone. Drawing heavily on Weick's conceptualization of loose and tight couplings, Dubois and Gadde (2002) concluded that this fragmentation and focus on short-term outcomes and efficiency, which comes at the expense of organizational learning and innovation, cannot easily be changed. Any such changes will necessarily change the nature of other couplings in the system, which can ultimately lead to new or unforeseen uncertainties and interdependencies.

Taken together, the challenges highlighted above suggest that the construction industry, similar to other project-based dispersed organizations and industries, has a significant set of forces acting against it. These challenges have contributed to the relatively slow increase of innovative capability in the industry (Styhre, 2009; Quintas, 2005). Highlighting these challenges suggests that there are opportunities for improved communication practice that may help alleviate or manage some of these common issues. In order to better understand where and how communication practice can

influence the ability of construction firms to operate more effectively, a review of the current nature of knowledge management in the construction industry is needed. Before that, however, I'll explain a little about my time in the industry.

A Note on My Experience

Before continuing the discussion on the current understanding and prevalence of knowledge management in the construction industry, I want to pause for a moment to reflect on my personal experience in the industry. In doing so, I hope to illuminate some of the challenges I've just identified.

Throughout my years in school I have worked various jobs during the summer months. Most of those summers, starting back as early as 7th grade, I spent working concrete construction. While much of my employment was with a small local contractor who did residential concrete work, I did have an opportunity to work for a medium sized regional concrete construction organization based in the Midwest prior to starting my master's degree. I worked for my older brother, who was a project manager for the organization, and over the course of about 5 months I held various positions ranging from laborer to temporary project manager (I was able to oversee a project for about a week while another project manager was on vacation). Based on my personal experience, conversations with my brother and numerous project managers, and a president of a concrete construction company, I've had the opportunity to hear about or experience some of these challenges. As such, I will convey a few anecdotes that will help put some of these aforementioned obstacles into context.

My brother reiterated the point regarding conflict of expertise in a story: He was working on a large hospital and shared project management duties with another individual from his company. The other, more senior project manager kept insisting that Eric create and update a project schedule that intimately detailed their projected deadlines and progress. Eric knew from past experience that projected schedules like this were never accurate due to the inherent uncertainty about weather and other unforeseeable delays (i.e. each project is unique and there will always be unforeseen delays). As a result, Eric was convinced that it would be an unnecessary waste of time to repeatedly re-write a schedule that he knew they would not be able to stick to anyway. Eric preferred to have particular goals and perhaps some major deadlines established. As a result, he consistently refused to create a detailed schedule for his colleague and instead moved forward in a manner that he knew to be reasonable and effective. When Eric reflected on this conflict, he retroactively made sense of what he perceived at the time to be unnecessary and wasteful work. Eric realized that his colleague knew such projected schedules were not likely to be accurate, however he needed a reference point to make sense of their progress, which would allow him to evaluate their practice and understand where improvements could be made and where things were outside of their control. This conflict of expertise also relates to the issues of time pressures, as Eric felt that taking time to re-write a schedule each week could be better spent in other areas that were more pressing or deserving of his limited time on-site.

When posing a question to individuals in the industry regarding the nature of KM in their organization, I received different answers as to why there aren't more established

KM procedures among U.S. construction companies (including their own). Eric assumed that compared to other cultures and countries where KM appears to be more valued, the U.S. system moves a much faster pace, and therefore there isn't time to invest in KM development before, during or after each project. In my experience with the organization, I was able to see first hand how time pressures can get in the way of innovation or development of new practices.

When filling in for a project leader who was on vacation for a week, I had the opportunity to participate in a project-wide weekly meeting that included all of the subcontractors who were employed by a general contractor (GC) on that job-site. Just before joining the meeting, I was asked to step outside to speak privately with the GC about the upcoming meeting. He expressed to me that the plumbers were holding up my schedule, and subsequently his schedule (something I was unaware of as I hadn't been briefed on the project's status before coming on site). He asked me to call out the project manager for the plumbing company during the meeting so that he could then address the issue and request that the plumbers direct additional resources towards completing the floor drains by the end of the week. As I had just arrived on the job-site the day before and was unaware of the ins-and-outs of the project schedule and relationships between the GC and his subcontractors, I obliged his request. This entire interaction, which resulted in the plumbing project manager avoiding answering any of my questions for the rest of the week, was based on the fact that the project was beginning to get behind schedule, which would mean that the GC would incur financial losses. Because many projects are bid with such tight profit margins and parameters in order to win the work

for the company, any delays can result in significant losses on the bottom line, ultimately meaning there is often little interest in slowing down to learn new, unproven approaches.

The president of Eric's company, on the other hand, cited the major impediment of KM practice in his organization as being less an issue of time constraints, and having more to due with the fragmentation of the industry. He conveyed that because there are so many different organizations and personnel involved in each project, there's little opportunity, interest, or space to address KM needs. Additionally, as each employee holds unique expertise and talent, he talked about how difficult it was to even get his own organizational members to effectively share and utilize the knowledge resources that were spread across several states.

When I was acting as a stand-in project lead on the construction site, one of the first issues that the crew ran into was a discrepancy between the engineering specifications and what they new to be necessary when pouring the concrete for an outside side-walk. This was a clear example of the engineer not being aware of the physical implications of the designated specifications. The building drawings indicated that an exterior sidewalk would actually slope towards another door opening and corner, essentially funneling water into the building. Any engineer knows the necessity of slope on a concrete walk or driveway in order to manage the evacuation of water in a desired direction away from the building and towards a drain or ditch or grass yard. However, this particular engineer or more likely, engineer design team, had not considered the confluence of sidewalk, pedestrian door opening, concrete wall, and overhead door opening. In theory, the sidewalk sloped away from the pedestrian doorway and the

building, but because the concrete wall funneled any run off water towards another door that was at a lower elevation than the pedestrian door, the concrete construction crew new that there would be water issues in that particular spot. On paper, the specifications didn't pose any problems, but in reality, the craftsmen knew that the design wasn't going to work well.

The craft's ability to move forward on the project was halted as we all discussed the nature of the issue and decided what elevations needed to change in order to provide enough slope in the right direction to direct the way out and way from the building and into the driveway. This embodied expertise demonstrated by the crew was in conflict with the design team, but know one ever communicated that issue beyond the small group of us who were attempting to implement the commands of the blueprints. As such, a conflict of expertise was engaged, but luckily for us, it was easy enough to find a solution using the know-how of the people on site with no major changes to the design of the building. However, a small amount of time was taken to work through the situation, and it can be easy to imagine how larger problems and conflicts between the head and the hand could be much more time consuming and costly.

These examples demonstrate how the challenges associated with architecture, engineering and construction work can impede the development of more effective and innovate work practices. These anecdotes represent my personal framing of the industry and helped inform some of the questions that lead to the development of the research projects contained in this document. Through my interactions with the industry, I've been able to identify a few opportunities for research that may provide useful insight for

those who think about how we communicate what we know in the workplace, as well as those who are engaged in the communicative accomplishment of knowledge work in their organizations everyday. Before previewing my research interests with this project, the following section takes a look at the past research activity related to knowledge management in the domestic construction industry.

Knowledge Management Research Activity

A few studies have documented the degree to which knowledge management research is being conducted across the globe. Kanapechiene et al. (2010) organized several KM models from the academic literature and provided a list of authors along with their respect countries. Including the model developed by Kanapechiene at al. (2010), only one out of the 12 models originated in the United States. More recently, Forcada, Fuertes, Gangolells, Casals, and Macarulla (2013) highlighted 11 studies and claimed that most of the research in this field is being conducted in the United States, the United Kingdom, and Hong Kong. Forcada et al. (2013) identified three of those research projects as being conducted in the United States: Carrillo and Chinowski (2006), Javernick-Will and Scott (2010), and Zerjav, Hartmann and Javernick-Will (2012). However, of those three, only Carrillo and Chinowski (2006) reported on the nature of the domestic construction industry (and compared it with that of U.K's), while the other two focused on larger multinational firms. Javernick-Will and Scott's (2010) extensive study used 113 informants from three different types of expressly multinational firms (engineering consulting, contractors, and real estate developers/owners), with only three of those firms and about 20 informants representing

the United States (other countries represented were the U.K., Norway, Sweden, India, Greece, Japan, Canada, and Finland). Zerjav, Hartmann and Javernick-Will (2012) also focused on multinational firms who did strictly design and engineering work. Their informants came from the U.S., U.K., Germany, Netherlands and Canada, and their results had nothing to do with the nature of knowledge management in the domestic market, but was instead interested in the institutional knowledge needed by global firms as they work abroad. None of the studies mentioned by Forcada et al. were interested in assessing the nature of KM practice in the domestic firm. This points to an important gap in the literature that this research project will attempt to address.

Where the research activity is taking place is important, as national cultural norms play a significant role in our organizational lives (Hofstede, 1980). It is necessary to investigate the status of KM in this country to have a better understanding of how professionals and practitioners view the subject in their organizations. As Canary & McPhee (2011) pointed out, knowledge is used and valued differently based on context. This research project aims, in part, to provide a more thorough understanding of KM practice among domestic construction companies. Beyond attaining an updated understanding of how domestic construction firms view knowledge management, it is valuable to understand what tools and/or systems they currently utilize in their organizational practice.

Overview

Based on all of these challenges and apparent gaps in the literature, this research proposes to investigate the communicative practice of knowledge management among

U.S. construction companies. Many have recognized that knowledge lies within the individual and is constituted in our relational communication (Bartholomew, 2009; Bresnen et al., 2003; Brown & Duguid, 2002; Styhre, 2009). Taking a communicative perspective in this investigation will allow for a breadth of methodologies and theories to be utilized, while maintaining a clear recognition that communication creates and shapes organizational work life.

Two interdependent studies have been developed and implemented in order to further the understanding of knowledge management (KM) in the domestic construction industry. The use of information technologies for KM have ultimately fallen short as they're limited in the ability to capture tacit knowledge and lived experiences that constitute the bulk of knowledge resources in situ (Bartholomew, 2009; Emmitt & Gorse, 2003; Quintas, 2005). Instead, it is necessary to gain insight into the everyday talk that is utilized to manage what we know (Kuhn & Jackson, 2008). It is in the conversations, interactions and connections that knowledge accomplishing episodes can be seen. Investigating this level of practice is essential in understanding how our daily communicative activities shape the knowledge accomplishing ability of people and the firm (Kuhn & Jackson, 2008). In order to do so, an in-depth look into the talk and and experience of knowledge work in the construction industry is needed. Chapter III consists of an ethnographic study that investigates the daily communicative knowledge work that takes place within a regional construction organization. This chapter highlights how particular elements of Kuhn and Jackson's (2008) framework for practice-based research on knowing punctuates the knowledge activity among project members. In

addition, the study highlights new insight to inform Kuhn and Jackson's framework with the consideration of embodiment as an additional situation framing resource. Chapter III also considers the nature of systemic communicative knowledge practice through the investigation of scalable transactive memory systems to the organizational level.

Another way to address the lack of research and collaboration among practitioners, industry members and scholars regarding knowledge management and construction within the United States, is to evaluate the current levels of KM implementation and awareness more broadly. Research of this kind would go a long way in establishing the validity of the concepts, their potential relationship to organizational outcomes that the industry is currently struggling with (i.e. timeliness, product quality, and fiscal responsibility), and areas most ripe for future collaboration. Chapter IV takes on that task through the use of survey research to gain a general perspective on the domestic industry's understanding and use of knowledge management. In particular, the chapter assesses survey research to identify a motivating institutional pressure that drives the adoption of knowledge management practice and tool use. The study aims to provide empirical evidence of the relationship between knowledge management and a firm's ability to maintain or increase their competitive advantage by relating knowledge management adoption pressures to organizational outcomes.

Before moving into the two research studies, however, Chapter II will outline how the literature conceptualizes knowledge and the many ways organizations have attempted to manage it in the past. This review largely pertains specifically to the context of project management for the architecture, engineering, and construction (AEC)

industry, and what it means to take a communicative approach to the examination of knowledge and knowledge management. The literatures on knowledge and knowledge management is vast, as nearly every discipline has approached epistemology from their perspectives and related contexts. So this review is inclusive, but not exhaustive of the major knowledge management works that shape the field today. Through this review, several broad research questions will be highlighted that identify the areas where the two research studies will attempt to make contributions.

Finally, Chapter V concludes with a review of each of these research agendas and their pertinence to the overall question of how we can improve knowledge management in the domestic AEC industry. The review will highlight the findings from each project independently before considering the practical and theoretical implications of this research endeavor in total. The chapter will wrap up with some opportunities for future research along with related propositions.

CHAPTER II

WHAT IS KNOWLEDGE AND HOW IS IT MANAGED?

Organizational Knowledge History

The first conceptualizations of knowledge as it pertains to organizations and organizing involved a division of labor and the establishment of a hierarchy based on rational distinctions of expertise and specialization (Canary & McPhee, 2011). Those who had a working skill were elevated from the common laborer. Scientific management perspectives followed with the dehumanization of the workplace and a further concentration of power and formalized knowledge among the top levels of the organization during the industrial revolution. Engineers designed, leaders directed and controlled, and deskilled workers operated as cogs in a wheel. This perspective changed with the Human Resource Management (HRM) movement that served as a reaction to the strictly and autocratically controlled scientific management movement. HRM now emphasizes the importance of individual knowledge expertise as a resource to the organization (Canary & McPhee, 2011). This change in epistemology had a ripple effect in other social science fields:

> Although many human resource management ideas were more relevant to motivation, the varied notions of organizational learning, increased employee responsibility, and cultural knowledge naturally led to more reliance on looser management, socialization, expertise, and group cooperation to make room for employee contributions. And all of these are early concepts whose interrelatedness is part of the concept of organizational knowledge. (Canary & McPhee, 2011, p. 3)

Knowledge management became a popular term in the 1990's as manufacturing decreased and the professional and technical sectors experienced large boons (Styhre, 2009).

As a result of this new perspective of knowledge in the organization, it's nearly impossible to distinguish the use of 'pure' knowledge from flexibility, high levels of motivation, social skills, less esoteric technical skills, abilities to follow company SOP's, etc. (Alvesson, 2001). The investigation, utilization and conceptualization of knowledge and how it is managed has come to the attention of a variety of fields, for reasons I'll discuss a little later. While Alvesson made this argument for knowledge-intensive firms, where evaluating the real use of knowledge is near impossible, project-based organizations have concrete observable outcomes (sometimes literally concrete structures) from which the successful use of knowledge work can be evaluated. So why can't we just evaluate knowledge management by those tangible outcomes? It's important to recognize, that we cannot simply look at a finished product and discern the efficacy of the practices used to coordinate and construct it, let alone prescribe much individual agency in such complex structures as those seen on most construction sites. This is because a costly delay isn't evident in the final product, and knowledge is just as much about the process as the outcome. Alvesson argued that final products aren't the best form of evaluation for knowledge work, "The ambiguity of knowledge and the work of knowledge-intensive companies means that 'knowledge', 'expertise' and 'solving problems' to a large degree become matters of beliefs, impressions and negotiations of meaning." (Alvesson, 2001, p. 870). Because beliefs, impressions and negotiations exist

in our shared communicative activity and the relationships that are necessary, for example, to construct a building, communication is at the center of many of the questions and challenges associated with knowledge and how it is managed.

Anumba, Egbu, and Carrillo (2008) astutely pointed out that the focus on organizational knowledge and the related knowledge management practices have grown, particularly in the last few decades. This burgeoning body of literature is a result of globalization, competition, diffusion of new technologies, financial implications of intellectual property rights, changing procurement routes and work patters, the rights and contracts of employment, in addition to drastic changes to political systems and ethics (Anumba, Egbu, & Carrillo, 2008). These changes and advancements have made knowledge related concepts ubiquitous. Subsequently, there are as many definitions of knowledge and knowledge management as there are reasons to study it. For the purposes of brevity and clarity, I will utilize definitions that pertain to the particular contexts in which this investigation is situated.

Knowledge Management in the Construction Industry

Knowledge management is "the conscious attempt by managers and individuals to make themselves and their organisations more capable by taking better advantage of opportunities to learn, and by sharing knowledge more effectively" (Bartholomew, 2009, p. 31). Other knowledge management definitions are similar to Bartholomew's, and often focus on the proactive utilization of know-how that benefits or improves a firm's ability to perform (Carrillo & Chinowski, 2006). A generally accepted model involves three interrelated elements that organizations and individuals have to manage: data,

information and knowledge. “Most interpretations [of the relationship between data, information, and knowledge] are variations on the proposition that isolated facts are only data; when they are put in a context that makes them meaningful they become information; and information becomes knowledge when people absorb it and it becomes part of their mental tool kit” (Bartholomew, 2009, p. 29).

Knowledge processes play out in three ways. Bartholomew (2009) saw knowledge management essentially involving learning and development of new knowledge and expertise, sharing of tacit knowledge, and the recording of explicit knowledge in order to develop organizational memory that is accessible to all. This conceptualization was intended for a pracademic audience that is interested in practical, theory-based tools. It does not, however, recognize the constitutive role communication plays and the inherently relational nature of knowledge (Amin & Cohendt, 2004; Gherardi & Nicolini,, 2002; Kuhn & Jackson, 2008; Sole & Edmondson, 2002). Bartholomew (2009) did, however, provide a useful model of knowledge. He conceptualized organizational knowledge as only that which provides the organization or individual with the ability to *do* something. In other words, knowledge isn’t knowledge unless it provides what Senge (2000) called the capacity for action. Bartholomew (2009) saw the complexity of knowledge and KM as something that involves a multitude of elements such as intellectual skill (e.g. analysis, calculation, interpretation), beliefs, senses, interpersonal skills, body skills and information (i.e. things we know we know, and things we don’t know we know). Knowledge then, is a jigsaw of elemental pieces that must fit together to produce a capacity for action.

For Brown and Duguid (2002) there is a conflict between knowledge management and information management. Information is self-contained, self-sufficient and independent of the individual. Knowledge, on the other hand, is very much associated with the individual, and therefore much harder to disassociate from a person (i.e. it doesn't do well being shipped, packaged, stored, transferred). This is why knowledge is often referred to as "sticky," or difficult to share from person to person (Quintas, 2005). Knowledge is also how a knower understands. Having assimilated with information, experience, and interaction, knowledge involves, ultimately, meaning and organizing (Gherardi & Nicolini, 2002). Brown and Duguid's (2002) distinction between knowledge and information illuminates the dangers of knowledge loss that an organization can easily suffer if key personnel are lost. For example, Conrad (2011) acknowledged that when organizations lose members, they subsequently lose the knowledge they carry with them, which is why short term downsizing efforts are so dangerous and costly.

Polanyi (1997) distinguished between the knowledge of a strategy and how it works with the knowledge of when to use it. Thus, there is explicit knowledge (what it is and how it works) and tacit knowledge (when to put it to use). Brown & Duguid, (2002) described it this way:

> In making his distinction between explicit and tacit, Polanyi argues that no amount of explicit knowledge provides you with the implicit. They are two different dimension of knowledge, and trying to reduce one to the other is a little like trying to reduce a two-dimensional drawing to one dimension. This claim of Polanyi's

> resembles Ryle's argument that "know that" doesn't produce "know how," and Bruner's that *learning about* doesn't, on it's own, allow you to *learn to be*. Information, all these arguments suggest, is on its own not enough to produce actionable knowledge. Practice too is required. And for practice, it's best to look to a community of practitioners. (p. 134-135, emphasis in original)

For Styhre (2009) knowledge management is a little less formulaic. He argued that thinking of knowledge management only as a set of specific tools, models or clusters of practices inherently limits and constrains the possibilities of KM. Styhre (2009) preferred to conceptualize it as an epistemological category, "wherein various forms of skills and know-how are treated as an organizational resource that is contributing to the firm's long-term competitiveness and sustainable competitive advantage" (p. 1-2). Knowledge management becomes one way of seeing the complex system that organizations and organizing are comprised of.

So knowledge is an important organizational resource, but what has driven the continued interest over the last several decades? Zorn and Taylor (2004) argued that one of the reasons knowledge management has become a popular subject among management scholars today is a result of managers' desire to protect their intellectual capital during the use of downsizing. Spendor (2005) attributed it to something else even more simple, "Organizations normally generate slack resources, and the tendency to re-invent the wheel rather than seek out the local expert who has already done this is endemic. Better knowledge management can reduce this possibility" (p. 102). A survey of construction organizations in the U.K. revealed the the most common drivers for

knowledge management in construction involved things like the need for continuous improvement, to share valuable tacit knowledge, to disseminate best practices, respond to customers quickly, reduce rework, and develop new products and services (Carrillo & Chinowski, 2006). These internal motivators seem likely drivers for organizational members to engage in knowledge management practices and systems, but there are often institutional factors involved when industries or sectors begin adopting new practices on a large scale (Zorn, Flanagan, & Shoham, 2011). Because the communicative accomplishment of knowledge work takes place in contexts and relationships that are themselves imbedded in institutions and professional ideologies (Styhre, 2009), recognizing some of these institutional motivators and their relation to the growing adoption and wide-spread practice of KM would be a useful endeavor.

In order to properly understand how different forms of knowledge are created or used in the construction industry, Styhre (2009) argued that one must understand how occupations, professions and concepts of practice are demarcated. Essentially, occupations differ from professions on a continuum of entry barriers, with professions being much more difficult to gain entry then many occupations (e.g. becoming a lawyer vs. becoming a truck driver). So professions are defined by their ability to claim very specific and often challenging domains of expertise. Practice, then is something that both professions and occupations engage in on a daily basis as they carry out their work, but it is not a clean activity.

Pickering (2010) talked about the ‘mangle of practice’ as a heterogeneous assemblage of modeling what we know. In other words, the practice of knowledge is a

demonstration of what is understood to be accurate, true or appropriate in a given situation. No one person replicates that knowledge exactly, and the demonstration of know-how isn't the same from one example to the next. This makes for an imprecise exercise of communicating what we know. According to Acker (2005):

> Practice, as I use the term, includes production of material 'things,' virtual nonmaterial 'things,' the material and emotional production of human beings, and the ordinary activities of daily living. Practice is always infused with meaning, and usually informed by thought, although many ordinary activities are guided by tacit knowledge, not consciously evoked. (p. 46)

Knowledge is embedded in our everyday practice, and is an imperfect form of communicative action that allows for organizing to take place around who knows what. Knowledge management then could be thought of as the conscious effort to understand and shape embedded practice.

Sennett (2008) talked about embedding as the essential process for all skill, which involves the conversion of information and practices into tacit knowledge:

> If a person had to think about each and every movement of waking up, she or he would take an hour to get out of bed. When we speak of doing something 'instinctively,' we are often referring to behavior we have so routinized that we don't have to think about it. In learning a skill, we develop a complicated repertoire of such procedures. In the higher stages of skill, there is a constant interplay between tacit knowledge and self-conscious awareness, the tacit knowledge serving as an anchor, the explicit awareness serving as the critique and corrective. (p. 50)

This sounds similar to the narrative knowledge that is described by Stacey (2010) during an examination of Chia (1998):

> For Chia, the complexity sciences are a program of simplification with a thoroughly reductionist intent. He argues that truly complex understanding is provided by narrative knowledge, not propositional knowledge, which is always reductionist and intrinsically unable to deal with the complex at its own level of articulation. He holds that there is a fundamental difference between human social systems and natural systems and while the complexity sciences may offer useful explanations of inert systems, vital human systems require complex thinking inspired by philosophy, literature, art and the humanities...Human experience is continuous in time with the past, present and future flowing seamlessly in to each other as undifferentiated flux and flow. Raw, lived human experience is irreducibly dynamic and complex, an amorphous, vague, unwieldy shapeless mass and unorganized process of continuously becoming. The constraints on this formless essence of human experience are socially constructed and the human intellect chops experience up into discrete moments of time, differentiating, puncturing, isolating, classifying, and punctuating it. The purpose of this intellectual activity is to center and stabilize experience to enable action, but in so doing, it alienates people from their true experience. For Chia, it is an oxymoron to talk about organizations as complex. It is lived experience that is complex and intellect and organization are about simplification, and this applies to the complexity sciences as much as it does any other science. (p. 90)

The goal of simply capturing knowledge for some unknown use in the future, then, seems rather futile. This is because the process of capturing and codifying will inherently be unsophisticated, discrete, and lacking in the needed complexity to accurately reflect lived human experience.

Sennett (2008) recognized this challenge as he tells the story of Diderot's encyclopedia, which was an attempt to capture the tacit knowledge of the craftsman:

> The research soon ran into difficulty, because much of the knowledge craftsman posses is tacit knowledge—people know how to do something but they cannot put what they know into words. Diderot remarked of his investigation, 'Among a thousand one will be lucky to find a dozen who are capable of explaining the tools or machinery they use, and the things they produce with any clarity.' A very large problem lurks in this observation. Inarticulate does not mean stupid; indeed what we can say in words may be more limited than what we can do with things...Here is perhaps *the,* fundamental human limit: language is not an adequate "mirror tool" for the physical movements of the body. (p. 94-95)

The spoken word can not serve as an adequate mirror tool for human movement. It is one thing to tell someone how to drive a double headed 16 penny nail, and it's quite another to master the movement in a way that results in a perfectly driven nail in only three strikes, time after time (something that I have yet to master after years of summer carpentry work, as attested to by the bone that will forever be shattered in the tip of my left thumb). But, our abilities to communicate aren't relegated to language. There are many more rich forms of communication at our disposal. While language may not

suffice to communicate tacit knowledge, there are other ways we communicate what we know and know how to do.

What all of this signifies is that knowledge is ubiquitous in the workplace. It is not a "thing" to be moved from one place to another. Knowledge is not an organizational resource that can be relegated to a particular department or individual, but instead must be coaxed into working in all organizational endeavors. At best, organizations attempt to manage it with communicative acts that allow projects to move forward in a given instant, in other words, that capacity for action (Senge, 2000). Grounding my work in a communication perspective will help to provide a lens through which to view knowledge and knowledge work, and will shape the particular questions and hypotheses outlined in Chapters III through V.

A Communication Perspective on Knowledge Management

Understanding and working from a perspective that recognizes organizations and organizing as being constituted in and through communication (Cooren, Kuhn, Cornelissen, & Clark, 2011) means that this proposal of inquiries follows the propositions outlined by Cooren et al. (2011) as they articulated what it meant to take a communication constitutes organizations (CCO) perspective. These include, most importantly to this endeavor, propositions like "CCO scholarship studies communicational events" (e.g. the talk between organizational members regarding a problem, Chapter III), and "CCO scholarship should be as inclusive as possible about what we mean by (organizational) communication," (p. 3). In taking up this tradition, the distinction between data, information, and knowledge (a classic, and still useful

distinctions among those who study the concept involved with knowledge and workplace) becomes less important, as all are subject to our ability to communicate and share understanding of them, in whatever the form. Then why focus on knowledge management instead of data management or information management? Data is easily stored and transferred and information becomes more complex as it pertains to a particular context, but is still relatively easily communicated in a way that allows for both parties to share mutual understanding. Knowledge, remember, is often sticky (Styhre, 2008; Thomas, Sussman, & Henderson, 2001), and therefor our ability to engage one another in a social situation where knowledge can become a mutually defined, useful tool, is paramount, and much more challenging than when dealing with data or information (although all may be used simultaneously). And so a focus on the conscious management of communicative actions and practice that constitute knowledge episodes could prove beneficial for those more complex and challenging situations.

Styhre (2009) alluded to this perspective when he concluded from years of qualitative investigation of the nature of knowledge management in the construction industry:

> To manage knowledge is to manage social relations and social relations are in themselves embedded in the abstract analytical categories that social researchers refer to as institutions, professional and occupational ideologies, and so forth. So if there is one single lesson from the three case studies, it is that knowledge is always social in essence and therefore the management of knowledge is the management of social relations. (p. 170)

Social patterns of organizational members have been strongly associated with the successful management of knowledge in project based construction firms (Bresnen, Edelman, Newell, Scarbrough, & Swan, 2003), and there is even some evidence that attending to relational aspects of knowledge work leads to increases in organizational innovation, at least among accountants (Fu, 2015). This should indicate to domestic organizations that attending to their social relations and knowledge management activity should lead to increases in tangible organizational outcomes. If nothing else, it should help reduce the rework and "reinventing of the wheel" issues that are common among dispersed project based organizations. There appears to be a barrier, however, for many organizations who believe there is value in knowledge management tool use. Relatively few firms been able to develop and implement full knowledge management systems (Carrillo & Chinowski, 2006; Forcada, Fuertes, Gangollels, Casals, & Macarulla, 2013). Therefore, it would be useful to provide further empirical evidence of the benefits that result from the concerted effort to engage in and maintain systematic knowledge management practice, particularly among domestic construction companies. That is an endeavor this research intends to take on.

Beyond the tangible outcomes, a communicative perspective also informs organization theory in three important ways according to Kuhn and Jackson (2008):

1. It foregrounds knowing over knowledge. Knowing is action oriented, denoting a capacity to problem solve in the moment given one's understanding of the situation.

2. Knowledge is deeply communal in the sense that communities play a central role in our interpretation of interactions or observations and what is valued versus what is not. This also means that there are significant communal barriers that impede cross-boundary working due to the situated nature of communal knowledge that is not found elsewhere (Carlile, 2002).
3. Lastly, the practiced-based view sees knowledge in a given context as the resource needed to move forward, to engage and overcome obstacles, and not necessarily that which can be identified as objective truth.

Knowledge is not a commodity which can be packaged or distributed, but instead is a change of focus from what we know to how we persuade others that we posses the expertise and rationality to address certain problems (Alvesson, 2001). This further allows us to conceive of all work as knowledge work that requires the social recognition of others (Alvesson, 2001).

Knowledge then, is largely a social phenomenon that relies on relationships (Gherardi and Nicolini, 2002; Kuhn & Jackson, 2008; Styhre, 2009). As this idea becomes more apparent, "The importance of people as creators and carriers of knowledge is forcing organizations to realize that knowledge lies less in its databases than in its people," (Brown & Duguid, 2002). This means that much of our knowledge relies on who we've worked with and learned from in the past. The relationship serves to alleviate uncertainty about a service or product. As a result, a high level of uncertainty often needs to be offset by working with those we already know (Alvesson, 2001).

Project based communities of practice (Lin & Lee, 2012) can rely on one another to reduce problem solving times and accuracy by drawing on previous project knowledge where similar situations were addressed. In other words, previous interactions help inform what one knows about the other, and what knowledge can be drawn upon to help move a project forward. This is often referred to as absorptive capacity, which indicates the degree to which previous experience and expertise allows for further immediate understanding of a given situation (Szulanksi, 1996).

This is a double edged sword, however, as knowledge-intensive workers must manage ambiguity and identity to a much larger degree than those whose organizational outcomes are materially grounded. Identity work becomes a primary endeavor for the knowledge worker who is ultimately evaluated subjectively. Because of this, "The unpredictable, relationship-dependent and fluctuating character of this kind of work thus makes it difficult to accomplish and sustain a stable, steady growing feeling of competence and respect," (Alvesson, 2001, p. 878).

While those in knowledge intensive firms may feel more susceptible to shifting identity and validity concerns as they attempt to carve out their contribution and positive self-image, it may not be so hard to imagine those who are evaluated on more material outcomes in project based organizations having to endure similar challenges. Construction organizations are inherently reliant upon individuals who have the capacity to manage relations with internal and external stakeholders while simultaneously coordinating knowledge with a multitude of interdependent contractors and skilled labor in order to produce a product, albeit a much more tangible one. But Alvesson (2001) is

correct in acknowledging that just because one can physically evaluate an outcome does not mean that one can evaluate individual contributions or a group's ability to complete a task or project prudently. This indicates a need to better understand the nature of communicative knowledge accomplishments in the physical and intellectual work conducted within and among construction organizations.

This introduction and review have identified several important questions that deserve further investigation. First, by identifying the lack of research and attention being paid to knowledge management practice in the domestic industry and scholarly research agenda, the introduction suggested that further research is needed to identify the current nature and attitude toward knowledge management concepts and practice. Second, there appears to be a lack of understanding behind the driving forces of knowledge management adoption and implementation. Third, others have argued that knowledge management adoption and use has been limited across construction industries because of the lack of evidence to demonstrate where organizations stand to benefit from it. As a result, questions still remain about the efficacy of knowledge management practice. Lastly, this review highlighted that a more nuanced view of knowledge management practice was needed. Chapter III picks up this last question with an ethnographic study of the communicative accomplishment of knowledge management practice within a domestic construction company.

CHAPTER III

THE COMMUNICATIVE ACCOMPLISHMENT OF KNOWLEDGE WORK IN THE CONSTRUCTION INDUSTRY

Introduction

The construction industry will be responsible for over a trillion dollars worth of work in the United States in 2015, up 13% from projections in June a year ago, and a total of nearly 20% from two years ago (U.S. Department of Commerce, 2015). The growth and shear size of the construction industry means that it is an essential part of U.S. financially and material infrastructure (U.S. Department of Commerce, 2015). A firm's ability to manage its resources and maintain profitability and competitive advantage is of utmost importance in industries that are as highly saturated and relatively undiversified as construction (Eccles, 1981). Knowledge is often considered a firm's greatest resource, and simultaneously the most difficult to manage (Bartholomew, 2009). Knowledge management is an organizational practice that can allow firms to differentiate themselves from their competitors as knowledge resources can contribute to competitive sustainable advantage (Styhre, 2009).

Knowledge work is most often associated with the "knowledge economy," a term typically related with professions such as lawyers, engineers, or researchers (Powell & Snellman, 2004; Styhre, 2009). Knorr Cetina (1997) argued, however, that the knowledge society encompasses all aspects of our work-lives and in fact has become essential to daily processes, experiences and relationships, and therefore, it must be a matter of importance to all industries and all organizational members. The construction

industry also has several shortcomings that indicate the need to innovate and find new practices.

As the context changes, so does the nature of the knowledge and its application (Sole & Edmondsun, 2002). Location matters when it comes to the dense face-to-face interactions that knowledge requires to flow within a network from where it is to where it needs to be (Brown & Duguid, 2002; Cross & Sproull, 2004), and construction work is highly dispersed (Zorn & Taylor, 2004). Each project is novel, meaning that contractors, engineers, craftsmen, and suppliers are rarely solving the same problems twice, thus complicating the reapplication of information or common know-how (Emmitt & Gorse, 2006; Kazi, 2005). Lastly, time and materiality play a large role in constraining the industry's ability to develop new practice, as projects orient firms to focus on short term deliverables, meaning there is little incentive to invest in systemic practices that may or may not pay off in the long run (Dubois & Gadde, 2002; Fong, 2005). In order to better understand how the communicative practice of knowledge can function in the industry and respond to these challenges, this study answers Kuhn and Jackson's (2008) call to develop a more coherent practice-based perspective of knowing in the organization. Specifically, this paper utilizes Kuhn and Jackson's (2008) framework in an analysis of the communicative accomplishment of knowledge work in a construction organization.

Relevant Literature

Knowing as Practice

Practice consists of what individuals do and say in organizational settings. Practice refers to taking part in a language game, where language informs our way of

acting, instead of merely serving as a method of transmission (Cook & Yanow 1993; Gherardi & Nicolini, 2002). The so-called practice turn in the social sciences (Schatzki, Knorr Cetina, & Savigny, 2001) encompasses working, learning, innovating and creating. As such, practice is an inherently social act that accounts for, and is constructed through, our communication in day-to-day activities (Kuhn & Jackson, 2008). As a result, the concept of practice is an "analytical tool that helps bridge the particular and local and the universal, the idiosyncratic and the collective," (Styhre, 2009, p. 22).

Gherardi and Nicolini, (2002) argued that learning, knowing, and practice cannot be clearly separated, that they are inherently concomitant, and that knowledge is constituted in the language, conversation, and discourse of our daily social interactions. Additionally, because knowing is action oriented, knowledge is both an outcome and a process (Davenport & Prusak, 1998). Therefore, knowing is not merely an output of organizational activity; meaning it takes more than information technologies to capture the "lessons learned" from project experiences (Bartholomew, 2009; Quintas, 2005). In order to understand how knowledge and knowing are accomplished by our communication work, the focus must be on day-to-day practices, and not on the explicit outcome alone. By elucidating the communicative accomplishment of knowledge, it is possible to see the reflexivity involved with the conscious or unconscious actions of managing an organization's knowledge resources (Tsoukas & Vladimirou, 2001). It is vital to understand that knowledge management happens in every firm, to some degree, as work is inconceivable without knowledge (Quintas, 2005). What becomes important then, is how the firm approaches the conscious effort, or practice, of managing its

knowledge resources. The construction industry is beginning to pay attention to their own practice.

Knowledge management is becoming an important part of the construction industry. Quintas (2005) suggested five drivers that have brought the consideration of knowledge to the forefront of organizational leaders minds: (a) that organizational value and wealth are increasingly tied to intangible knowledge related assets (e.g. intellectual property, patents, brand value, etc.); (b) the realization that the human resources (i.e. the people) are the keepers of such organizational knowledge; (c) the increasingly accelerated change in industries related to technology, markets and competition that requires firms to always be learning and responding; (c) that innovation, which drives market competiveness, is directly tied to a firm's knowledge resources; (d) and lastly, the growing importance of cross-boundary knowledge transactions. Styhre (2009) also emphasized the need for innovation in the construction industry that might produce new insights and knowledge managing practice, as the industry lags behind other sectors (e.g. manufacturing) in its ability to create new methods, technologies, and perspectives that allow for improvement.

Domestic construction organizations (not unlike their U.K. counterparts) are becoming aware that benefits could arise from adopting new knowledge related practice beyond the simple management of information (Carrillo and Chinowsky, 2006). Messner (2003) argued that the U.S. construction industry is interested in the usefulness of knowledge management research, beyond the confines of the contractors, to the entire construction lifecycle (e.g., design, supply chain, maintenance and sustainability; see

Miller, Casey, & Konchar, 2014, for an example this kind of collaboration and extension across common industry silos). Given the social constitution of knowledge (Amin & Cohendt, 2004; Gherardi & Nicolini,, 2002; Sole & Edmondson, 2002), communication practice is requisite to the accomplishment of knowledge in the workplace (Kuhn & Jackson, 2008). Communication creates the opportunities for the 'co-production of knowledge.' This investigation, as a result, is taking a communicative approach to understanding the practice of knowledge work in the construction industry.

Answering Kuhn and Jackson's (2008) call to develop a more coherent practice-based perspective of knowing in the organization, this paper utilizes their framework in an analysis of the communicative accomplishment of knowledge work in a construction organization. The analysis illuminates and builds on the intersections of Kuhn and Jackson's (1998) three interrelated situation framing resources (identification, legitimacy, and accountability) in the context of a "learning-in-organizing" approach adopted by the organization (Gherardi & Nicolini, 2002), the relational communicative knowledge management activities that make up that approach, and capacities for action that are a result of communicative knowledge efforts (Senge, 2000). In addition, this investigation will attempt to identity the common communicative practices that occur within and among team based organizational structures, following Peltokorpi's (2014) investigation of organizational mechanisms that help to establish transactive memory systems. To do so, this study draws on qualitative data gathered from three intraorganizational sites to attempt to untangle what Pickering (2010) refers to as the 'mangle of practice'. Before describing how this methodology was implemented and

more about the research sites, a brief review of the relevant literatures follows with related research questions.

Transactive Memory

Organizational actors rely on one another to manage their collective expertise through the development, maintenance and utilization of knowledge networks that help organizations, sub-units and individuals to produce, diffuse, and absorb knowledge (Phelps, Heidl, & Wadwa, 2012). One way of understanding how a network of relational communicative practice promotes and sustains knowledge resources among groups is called transactive memory. Transactive memory theory asserts that group members share cognitive labor associated with interdependent tasks by dividing the information required to address that task among distinct knowledge domains. A transactive memory system is a structure where people in relationships encode, store, and retrieve information about different substantive domains (Ren & Argote, 2011; Ren, Carley, & Argote, 2006). Thus, "Members rely on one another to be responsible for specific expertise such that collectively they possess all of the information needed for the task," (Lewis, 2003, p. 587). A transactive memory system then is a cooperative endeavor to remember, learn, and communicate knowledge (Wegner 1987), and as such can be seen as a useful tool for analyzing the communicative accomplishment of knowledge work. Recognizing and supporting formal or information organizational communicative practices that facilitate transactive memory systems, might also facilitate organizational knowledge management.

Transactive memory system (TMS) development and use involves three interrelated steps. Understanding who holds what expertise is the first step in developing a TMS (Wegner, 1995). Expertise recognition or directory updating is where individuals recognize and catalogue which people hold what types of expertise and knowledge (Hollingshead, 1998). Much of the work on TMSs has argued that this process is best and most often facilitated or mediated by the degree of closeness and familiarization team members have with one another (e.g. Wegner, Erber, & Raymond, 1991).

The second important process is information allocation or information provision. This process is focused on the distribution of relevant information to those in the group who are responsible for storing that information (Huang, Barbour, Su, & Contractor, 2013). This step sets TMSs apart from related concepts like team mental models or cross-understanding (Ren & Argote, 2011). By allowing each team member to be responsible for their own sub-domain, the team becomes differentiated in what they know, meaning each member has greater knowledge specialization.

The third process is information retrieval. When individuals have been able to properly recognize the expertise of others in their group, they can then seek out those respective team members when they are in need of information regarding that expertise domain (Hollingshead, 1998). This is the action phase of the process where information is then put to use as it is retrieved from the source as it is needed.

Groups can vary significantly in their development of TMSs depending on the differentiated or integrative nature of the groups and expertise domains involved (Gupta & Hollingshead, 2010). “A differentiated transactive memory occurs when different

items of information are stored in different individual memory stores but the individuals know the general labels and locations of the items they do not hold personally," (Wegner, 1987, p. 204). At the other end of the spectrum, an integrated structure would consist of members knowing the same information with overlap in the collective knowledge. In the experimental study reported by Gupta and Hollingshead (2010) on intellective tasks, differentiated groups exhibited more task clarity, as different members are more specialized and responsible for unique information. Groups with more integrated memory systems, however, experienced more collaboration, speed and accuracy (Gupta & Hollingshead, 2010). Transactive memory systems have shown to provide many benefits to the group work practice and outcome (Faraj & Sproull, 2000; Hollingshead and Brandon, 2003; Lewis, 2004; Peltokorpi & Manka, 2008; Rau, 2005; Zhang, Hempel, Han, & Tjosvold, 2007), but further research is needed to determine how well these relationships carry over outside of the laboratory experiments where many of the benefits of of TMSs have been identified (Ren & Argote, 2011). Additionally, Ren and Argote (2011) suggest that there are unknowns regarding the scalability of the TMSs from the group to organizational level; something this particular study may be able to address.

Organizational transactive memory. Organizational design, particularly team-based structures and small unit sizes within the organization, influences an organization's ability to develop and coordinate organizational transactive memory systems (Peltokorpi, 2014). TMSs require knowing who knows what, and the network of an entire organization becomes to cumbersome for each individual to maintain an

accurate and up-to-date directory of expertise. In dispersed organizations, distance hinders the ability for informal or spontaneous interactions, and because organizational members are more likely to use people than information communication technologies to search for and retrieve information or know how, those distances become obstacles that technology does little to counteract (Cross & Sproull, 2004).

An investigation of the communicative accomplishment of knowledge work as a practice will provide insight into the usefulness of organizational design elements in their contribution to organizational TMSs, and ultimately a firm's ability to manage knowledge. Peltokorpi (2014) identified several propositions related to Ren and Argote's (2011) call for further research regarding organizational TMSs. To further test propositions identified by Peltokorpi (2014), particularly proposition one, which states: "Organizational design (team based structure, small unit size) facilitates the coordination of organizational TMSs," (p. 465), the following research question is posed: *What are the daily communicative activities that facilitate the coordination of knowledge and expertise in a project based organizational structure?*

The previous conceptualization of knowing as practice, and the potential role of organizational transactive memory systems in that practice, indicates a need to consider the relational components involved with the social nature of communicative knowledge management work. Peltokorpi (2014) considered this in his theoretical framework of coordinating mechanisms of organizational TMSs, as another proposition stated: "Relational interactions facilitate the coordination of organizational TMSs," (p. 466). This coordination, and communicative knowledge management practice also involves

the social processes of relating and learning (Cook & Yanow, 2011; Gherardi & Nicolini, 2002, Styhre, 2009).

Relational Communication and Organizational Learning

Knowledge is sticky (Kazi, 2005; Quantas, 2011; Szulanski, 1996), meaning it is not easy to separate from the knower. For example, being able to recognize when a particular area of a recently poured concrete slab is getting too hard too fast (potentially inhibiting the ability to finish the surface in the required fashion) is a hallmark of a knowledgeable finisher. The symptoms and causes can be explained, written down, or otherwise recorded easily enough. Unfortunately, those methods of capturing information do little to prepare the novice concrete worker for the challenge of *seeing* and *feeling* the material in regards to how it is responding in the moment to the environment. This challenge demonstrates a lack of absorptive capacity, which refers to one's previous experiences or prior related knowledge that allows one to recognize, recreate, or apply knowledge successfully (Szulanski, 1996). Bartholomew (2009) recognized the value/challenge tension organizations face with tacit knowledge, or the knowledge that is difficult to write down,

> The importance of tacit knowledge has both good and bad consequences for business. It means that the most valuable knowledge is hard to spread around an organization, but it also protects it from becoming widely available to competitors. That makes tacit knowledge a key resource of sustainable competitive advantage, and one of the main aims of knowledge management is to create more of it and make it flow more freely. (p. 23)

Our ability to engage in relational communication activities should engender further opportunities for communicative knowledge management practice, making it a valuable organizational asset. Styhre (2009) concluded about the relational nature of knowledge management,

> To manage knowledge is to manage social relations and social relations are in themselves embedded in the abstract analytical categories that social researchers refer to as institutions, professional and occupational ideologies, and so forth. So if there is one single lesson from the three case studies, it is that knowledge is always social in essence and therefore the management of knowledge is the management of social relations. (p. 170).

Recently, Fu (2015) provided clear evidence that activities which bring people together to share stories and develop mutual respect (i.e. relational routines) along with timely, accurate, and frequent communication practices that promote problem solving (i.e. relational coordination), led to increases in valued organizational outcomes like knowledge management and innovation. These findings support Peltokorpi's (2014) proposition that relational communication is important to knowledge management practice, and as a result, this study will attend to the relational practice as it is carried out in the construction firm under study.

Another social practice involved with the communicative accomplishment of knowledge work is organizational learning. Dispersed organizations consist of networks of relationships that rely on one another to engage in a learning process that involves communicating what they know. It is that practice that constitutes the organization's

unique "way of doing things," (Cook & Yanow, 2011). For Gherardi and Nicolini, (2002),

> Learning within organizations is therefore conceived as a social process, the goal of which is to discover what to do, when to do it, how to do it according to routines and using specific artifacts, and then how to give a reasonable account of why it was done. Learning takes place among others and through others. (p. 194)

Similarly, Cook and Yanow (2011) argued for a cultural conceptualization of organizational learning, one that is different from individual cognitive learning, or individuals learning within an organizational context. Instead a cultural conceptualization of organizational learning consists of the organization itself learning, but not in the same way individuals do. Their understanding of organizational learning involves the cultural artifacts and individual activities that constitute the organizational learning as a whole entity, where "that learning, in turn, is understood to entail organizations' acquiring, changing, or preserving their abilities to do what they know how to do," (Cook & Yanow, 2011, p. 368). This cultural perspective on organizational learning holds an important variation compared to much of the organizational knowledge research agenda, which is oriented around the solving of problems. Instead, a cultural theory of organizational learning is just as much about the maintenance of know-how, what went right, and preserving a continuity of success, as it is about focusing on the lack of knowledge, or only turning to knowledge management when something has gone wrong. In addition, Cook and Yanow argued that while the theoretical premises remain the same for the conceptualization of cultural organizational learning regardless of size

or complexity, these phenomena may be more easily seen in subunits of large organizations, much like the level of analysis taken in this study.

Based on these observations and the need to better understand how knowledge is communicated in those relational interactions that support an organizational learning culture and the communicative accomplishment of knowledge work, this study investigates the practice of communicating what we know with others with a second research question: *How is relational knowledge management practice related to cultural organizational learning in the project based construction organization?* This research project has engaged with a project-based organization in the construction industry, where knowledge related practices were observed and inquired about through an ethnographic field study.

Background and Research Sites

A project-based organization in the construction industry, referred to here as Constructors, was selected as a research site for this investigation. Project based organizations necessitate distinctive organizational structures that rely on dispersed teams to perform novel tasks in the field. As a result, their communication becomes challenged, even more than a centrally located organization, when they attempt to coordinate knowledge and expertise from team to team, and project to project. This particular organization was a medium-sized domestic enterprise specializing in concrete construction with multiple offices across the country. Each location bid on and built projects within about a 90-mile radius. Keeping work relatively local allowed project managers and craftsman to establish a more permanent residence. This also reduced

travel and lodging costs that are often paid for by the organization. There were occasions when individuals traveled much farther to their work (as far as eight hours), however those instances were very rare and were more often a result of the organization's interest in keeping people working rather than utilizing their particular expertise where it is most needed. This organizational structure created a network of independent, yet interconnected offices that tailored their work to their respective regional markets. At the time of data collection, the organization consisted of two main levels: the corporate level and the business unit level. The corporate structure of the organization was such that some locations, or business units, housed regional or corporate leadership positions for things like human resources, vice-president positions, and safety coordinators. Most corporate level individuals worked organization wide, while being collocated with their respective business unit colleagues. Each business unit focused on knowing their metropolitan market, bidding targeted jobs and constructing their projects.

Research Sites

Three of these office locations were targeted for data collection because of their location. The offices were all located in major metropolitan markets in the Midwest and were within a few hours drive of one another. This made it relatively easy to move among them in a short amount of time.

The organization functioned on multiple levels, or what they called "tiers." The largest tier consisted of what was called "the craft," including laborers, skilled trades, and field leads who served as leaders for those groups on their job sites. At the project tier, were project leads and project coordinators. Depending on the scope and complexity

of the job, project leads would often remain onsite with their craft while working with a project coordinator who might provide insight or direction, complete paper-work or other administrative duties. The project coordinators would also deal with financial issues or other sub-contractors, general contractors or owners who were on-site day-to-day.

The project coordinators and project leads worked together in a complimentary fashion to ensure the project met organizational goals and deadlines. This tier was also responsible for creating an implementation plan for how they wanted to accomplish the project once they were assigned to it by the operations tier and whoever was responsible for creating and winning the initial bid (often an operations coordinator who was designated for pre-construction).

The operations tier consisted of operations leads and operations managers, and mirrored the project tier in functionality, but at a higher level. These individuals oversaw multiple jobsites at once, were responsible for ensuring overall project success, but didn't engage in day-to-day activities unless necessary. The operations tier helped the project tier prepare for a project by reviewing the project tier's plan and adding advice or suggestions when appropriate (but they largely wanted the project tier to take "ownership" of the planning once the bid had been awarded to the organization and the material had been turned over to the project team), and by stepping in when needed to address bigger concerns, issues or opportunities.

Each business unit also had an area lead, or someone who was in the main leadership role for that unit. Each area lead was located in their respective office

locations, except for one of the sites observed, where the area lead had offices in two locations, meaning that he often wasn't in the office where he was the designated area lead. According to the website and organizational documents, Constructors had business units in 11 cities, although there was much talk during my time with them about the numerous locations that the company was looking to develop in the next year or two. Overseeing these 11 locations was a corporate tier of professionals including a president, vice presidents, human resources, etc.

For two of the three locations, the physical space was relatively new, and designed with open bullpen areas that housed several desks or cubicles with low walls. These bullpens were workspaces for project leads and even some field leads who spent a majority of their time on site, and they also served as over-flow space for individuals who traveled between different offices. Lastly, some administrative positions (logistics, purchasing, etc.) were also located in the bullpen areas. Surrounding the bullpen were office spaces that constituted the perimeter of the buildings. In both of these locations, one half of the office space was reserved for local managers and leadership (e.g. Area Leads, Operations Leads and Managers, and Project Coordinators), and the other half was reserved for corporate positions (VP's, HR, etc.). Additionally, one of the two sites was also home to the office of the organization's president, although that individual was often traveling and so the office often stood empty and dark.

The third location had not been around as long as the first two, and had recently moved into the office space of a local construction company that the organization had acquired. This location stood in deep contrast to the other two. Its doors were locked,

and there was no sign on the building indicating that the organization was housed there (the old business's logos were still present on the front door). Once inside, the communal office space was cluttered with unused furniture and four offices were contained in the main building along with a conference room, which also contained an overflow desk space. The office was equipped with Ethernet cables for internet access, as opposed to the other locations which had Wi-Fi networks. Through a back door (also locked to prevent unauthorized entry) was a hallway that led to two additional offices, a break room and conference room eventually led out into a workshop area in the back of the building. In the parking lot out the back door was a job trailer that had been set up to serve as an additional office space. This office was dark, dirty, and closed off.

On two occasions I was able to gain access to job sites where I could observe conversations and work being done by organizational members. Other than the few times when individuals came into the offices, these were the only opportunities that I had to speak with and observe the craft in their element. Unlike the office settings, both sites were large, in different levels of being completed, involved heavy machinery and any number of other sub-contractors who were completing their work on the site simultaneously. Access to these sites required safety protection and a general awareness of "how to stay out of the way." It's important to recognize here that my pervious work experience in similar settings had somewhat prepared me for interacting and observing on these job sites, as I had worked concrete construction for many summers growing up, and even spent a summer working for a large commercial company like Constructors on similar job sites. These experiences allowed me to better understand the work processes

being done, the conversations and language being used, and the overall project based work-life of the construction industry. While my experience was limited compared to nearly everyone else in the organization, my ability to "talk the talk" did engendered some amount of trust from many of the organizational members early on in our conversations as they realized that I had a basic understanding of their work. Others remained more skeptical about my intentions and chose to keep their distance. Adopting an ethnographic approach, I spent several weeks among the three locations through the winter of 2014-2015, splitting my time among the three locations.

Methods

Data Collection

Data were gathered from three main sources: interviews, observations and organizational documents. After contacting each of the three area leads to follow-up on conversations they had had with the organizational president about my project (who had given me entre to the organization and the respective business units), I made a point to sit down with each one of them as soon as I could to discuss in further detail the project, what I hoped to do over the coming weeks, and answer any questions they had. I also used this opportunity to begin a conversation about how we communicate what we know in the industry. These conversations helped shape some of the later interview questions that I included in my interview protocol, as I had more information about the structure and interactions among the various organizational tiers, project teams and business units.

Taking an observer-as-participant role (Lindlof & Taylor, 2010), a total of 20 days were spent with the organization, most of which were in the business unit office

locations. While in the offices, I attempted to find a central location that would put me in a position to observe the operations and conversations, while identifying opportunities to strike up conversation or interview organizational members when they were available. The offices with bullpens provided excellent empty desk space for me to occupy, where I could easily see who was around, conversations that were taking place, or when a meeting was about to start that I might be able to observe. The third location that didn't have a bullpen or open floor plan meant that I was using the conference room to jot field notes, and moving around the building to peak into offices to see what was happening. Interviews were more difficult to schedule in this location, and impromptu meetings often happened before I could identify them as such. Throughout my time with Constructors, I conducted 13 in-depth interviews with a semi-structured interview protocol (see Appendix A), observed 10 formal meetings, and engaged in or observed conversations among organizational members, sometimes contributing to the conversations or following up with a few questions about the interaction afterwards. I also attended one luncheon that took place after the holiday season where craft, project, and operations tier individuals got together for lunch at a local restaurant with one of their closer clients, a real estate and development organization that they had worked closely with for many years.

Fieldnotes taken from the observations, meetings and informal conversations amounted to nearly 60 pages of single-spaced, typed notes. Transcripts from the 13 interviews (ranging from 20 minutes to almost two hours) with project, operations, field, and corporate personnel totaled 356 pages. In addition, I was able to collect agendas

from several meetings relating to project planning and implementation, organizational growth/development, and new hire mentoring/onboarding. Organizational newsletters were also available in the offices, and information about the company was listed on their website. These documents totaled almost 40 pages of information relating to the functioning of the organization at multiple levels. Psuedonyms were used throughout the project so that field notes, interview transcripts, and any reporting of the data provided confidentiality to the participants and the organization. I continually attempted to improve my data throughout the collection process by using triangulation techniques in order to verify my interview findings (Yin, 2014). For example, when I heard an interviewee talk about a new planning protocol being implemented across the business units, I read about that process and announcement in the organizational newsletter, which provided additional background and supplementary information concerning the process. Any contradictions in the data were correct by checking a third data source if possible, or asking organizational members for clarification.

Data Analysis

This investigation has to main goals. First, it aims to illuminate and extend Kuhn and Jackson's (2008) framework for practice based research on knowing by using it to better understand that nature of learning-in-organizing and relational communicative knowledge management activities that provide capacities for action.

Second, it is concerned with identifying the common communicative practices that occur within and among team based organizational structures in order to better understand how they may provide opportunities for, or take advantage of, organizational

transactive memory systems. As such, the following analysis was utilized to answer the two interrelated research questions, which were 1) *What are the daily communicative activities that facilitate the coordination of knowledge and expertise in a project based organizational structure*, and 2) *How is relational knowledge management practice related to cultural organizational learning in the project based construction organization.* I used an interpretive analysis to highlight the intersections of theory and practice as they pertain to these two research questions.

Kuhn and Jackson (2008) argued that our knowledge work is framed by the negotiation of three interrelated resources: identification, legitimacy, and accountability. These interdependent resources are negotiated in the communicative practice of organizational members as they face a problematic situation. The negotiation of resources then frames the level of determinacy, i.e. the degree to which the problem can be addressed through simple information transfer (determinate) or more complex knowledge instruction or improvisation (indeterminate). My interpretive analysis layered these framing resources with the theoretical conceptualizations of the learning-in-organizing culture, and the relational communicative activities highlighted previously, which are ultimately part of the project-based organizational structure of Constructors. In addition, knowledge accomplishing episodes, which are the unit of analysis prescribed by Kuhn & Jackson (2008), involve movement towards action, or a capacity for action (Senge, 2000), and as a result, capacities for action were also included in the analytical framework. The resulting intersections, described as organizational practices, are

identified in Table 1. These practices, presented and organized by Kuhn and Jackson's (2008) three framing resources, are described in the following findings.

Table 1. *Communicative Accomplishment of Knowledge Work Interpretive Analysis: Analyzing Situation-Framing Resources.*

Situation-Framing Resources:	**Identification** **How actors assess discursive identifications to predict other's action and interpretation**	**Legitimacy of action** **"What does the group or organization expect of me here?"**	**Accountability** **Individuals look to certain members of an audience for direction and validation**
Learning-in-organizing culture is reinforced through…	Learning who knows what; Naming those who need to be involved in order to help one learn more about the problem	Structured occasions which lend legitimacy to the planning/learning process by providing a script for interactions and knowledge development	Presentation of building plans to operations level managers, feedback provided from operations managers (mutual accountability, mutual learning)
Relational communicative knowledge management activities include…	Directing questions to an actor who is determined to be a resource for the situation	Use of mentors, assigning projects to teams of project leads/project coordinators based on their ability to compliment one another's expertise and working ability	Incorporating owners, other contractors and upper-management in bidding and planning process in order to confirm viability and competitiveness
Capacity for action is realized when…	The best knowledge resource is recognized and considered in problem solving	Relevant actors embrace self-directed nature of planning and implementing projects, while engaging all levels of the organization	Expectations are met; actors and constituents concur on appropriate course of action given each party's mutually defined responsibility; new knowledge is created through involvement of actors with appropriate audience members

The Communicative Accomplishment of Knowledge Work

The framing resource of *identification* is the way in which actors assess discursive identifications to predict other's action and interpretation**.** The results highlight how identification resources are negotiated through a) the learning-in-organizing culture where individuals, teams, and even business units are identified by others as demonstrating particular expertise or are responsible for maintaining a certain

knowledge base, b) others relate to those who identify as experts or knowledge resources through the use of information retrieval and question asking, and c) capacities for action that are realized once those knowledge resources are found and put to use in problem solving episodes.

The *legitimacy of action* resource illuminates how organizational actors address the question, "what does the group or organization expect of me here?" Through the practices described in this section, the larning-in-organizing culture was observed that the organization had company wide structured occasions, which served to lend legitimacy to the planning/learning process by providing a script for interactions and knowledge development that may not have happened on their own. The relational communicative knowledge management activities were seen in legitimized mentor/mentee relationships. These practices also relied on structured occasions, as well as informal "checking-in." In addition, many project members experienced legitimizing affirmation when they were chosen or paired with others to manage a particular project where their relative skills and expertise could be utilized.

Accountability resources were negotiated in terms of the learning-in-organizing culture through the presentation of building plans from project tier individuals to operations tier individuals, as each tier held the other accountable for providing a strong, well informed plan, and clear, well informed feedback to that plan. Relational communicative knowledge management activities involved the negotiation of accountability between Constructor's employees, other contractors or owners, or other project stakeholders. This practice was used to hold one another accountable for

participating in the planning or problem solving process, and for following through on agreements, in order to maintain mutual viability and competiveness. Lastly, accountability resources were negotiated as capacities for action were realized in the concurrence of a planned program of action given each party's mutually defined responsibility, sometimes resulting in new knowledge creation through the involvement of appropriate actors and audience members. Each of these major intersections are further described with examples in the following sections.

Identification

The situation framing resource of identification refers to an individual's understanding of their own and others allegiances. These co-constructed identities, manifest in talk, help actors frame a situation and assess or predict interpretation and action. Identification acted as a resource for a learning-in-organizing culture at Contractors by creating a mutual understanding of who knew what, which allowed individuals or project teams to name those who should be utilized when a problem arose. Many organizational members identified themselves as a group who relied on the ability and openness to ask or answer questions, regardless of tenure, position, or perceived expertise level. Lastly, the identification situation-framing resource was fully operationalized when organizational members were able to achieve a capacity for action by utilizing the best knowledge resource for problem solving.

Learning-in-organizing culture. The learning-in-organizing culture at Constructor relied heavily on identification that allowed individuals and project teams to recognize who needed to be involved in a given situation, based upon their mutual

understanding of various identities within and outside of the organization. The identification resource also provided opportunities to share and update "who knows what," (Contractor & Monge, 2002), contributing to a network of recognized experts operating a pseudo transactive memory system. Organizational members often discussed with each other who might be best to tackle a problem, or which supplier or general contractor they wanted to team up with on a bid. The learning culture of the organization started with organizational members learning who knows what, and then naming those who needed to be involved in order to help them learn more about the situation.

Learning 'who knows what' was a compulsory and ongoing process that allowed organizational members to quickly and efficiently identify who they needed to talk with when they were confronted with a problem or situation they were unable to manage on their own. Similar to a transactive memory system, this organization consisted of more loosely defined knowledge roles that would often provide some indication of where expertise could be found in the network, but lacked much of the information allocation and updating of knowledge experts that is essential for a strong transactive memory system. Instead, learning who knows what, and to a lesser extent, updating who knows what, was done on a somewhat as needed basis when other factors allowed Constructor members to discuss previous projects. These information story-telling episodes would indicate who might have been involved with a situation, where they may have developed a new form of expertise, or gathered useful information that could be brought to bear on a later project.

Don, a pre-construction lead that was responsible for finding new work and overseeing the new bids for that work, reflected on his constant need to learn who to go to for what he wasn't familiar with,

> I'd say fairly often, there is something…if something comes up that I don't know, a lot of times people around here probably won't know either. And I have to seek out somebody to understand that. And so at that point, it's making phone calls and asking, "Hey, have you ever done this?" Or, "Do you know who I can talk to, to do this," and just figure it out.

Don spent a lot of his time developing relationships with other pre-construction leads in other Constructor offices, as well as in the community and among other contractors. His position required him to understand the bigger picture of the projects he was wanting to bid on in order to understand who would be a good fit to get sub-contracting quotes from, or who to go to if he had a question about a potential project. Don went on to described a hypothetical situation,

> If we had a job that came up that had um, elevator cores or stair cores, and we identified there's room onsite we could tilt them up as panels and stand them up and…we know it's worked in the past, that [other location] has done that. I would… I would start seeking out who was involved in that project and…I would pick their brain and understand that. Uh, or if it's a certain wall that's kinda fucked up in the way we'd have to form it or something like that, maybe bring in a former work supplier that's an expert on it.

For Don, the first step towards taking action on a project was to recognize who could help him and how. But as Don pointed out, he already had a large network of resources that he could call upon. Don knew who had done what kind of work in his own business unit, and he also appeared to be familiar with what the other regional business units had generally been involved in. This provided Don with a rather extensive directory to draw from when he need to seek out certain kinds of expertise.

Another example came from James, a relative newcomer to the organization. James had spent a lot of time in the construction industry working as a general contractor, where he described his role as having to "know a little about a lot of things." He explained how working for a company like Contractor was a new challenge for him because he had never worked for a concrete construction company before. While he was very knowledgeable about his management role and how to work with people to accomplish a goal, he often needed to turn to specific individuals who he felt he could trust. When it came to post-tension cabling (a method of strengthening a concrete slab by pouring the concrete around several large steel cables and then stretching those cables after the concrete had begun to cure to provide a stronger concrete deck), James relied on a project lead colleague, who he had come to identify as a person who could offer expertise about things like lead times on ordering materials and scheduling installation and tensioning. Once organizational members were able to identify resources and how they could contribute to their dilemma or project, various communicative activities were utilized to engage in problem solving and planning, one of the most useful and valuable

tools, however, was the ability to direct questions to a colleague who could provide insight to that particular situation.

Relational communicative activities. Organizational actors often identified themselves as someone who asked a lot of questions. Those who were perceived as being open to fielding inquiries were also strongly identified by others as being a resource for knowledge. Asking questions was an essential part of the informal expectations of the organization. Joe, an operations tier manager, commented matter-of-factly, "I think the guys that are willing to ask the questions will advance faster. The guys that are concerned about that perception get stuck." He likened one's ability to ask questions, which often meant a position of humility or openness, to the type of characteristic the organization looked for in their leaders and team members. He argued that one's ability to engage in the relational act of inquiry would strengthen their network of knowledge resources. This humbleness allowed individuals to identify as someone who lacked certain types of expertise, which is an important self-reflective practice that is necessary in transactive memory systems where individuals must rely on others to maintain knowledge domains that they themselves cannot. As a result of this recognition, asking questions was a valuable relational communicative knowledge management practice that was encouraged at all levels.

For example, Katy, a territory safety lead, identified strongly as someone who asked a lot of questions. She recognized the perception that asking a lot of questions wasn't the common activity in the industry, and then immediately reaffirmed her

organization's identity as one that did encourage the question asking practice among everyone,

> So, I probably can get away with it a whole lot more than a guy would, um. So asking the stupid question, being an overgrown four-year old asking why, why, why, why. And so I can get, you know, the guys cut me more slack than they would anybody else. But from what I have seen, not a single one of our project leads, field leads, or any of them would ever give somebody a hard time about asking questions.

This willingness to ask questions both reinforced the learning-in-organizing culture and required individuals to know who to direct those questions towards, hence the necessity of learning and updating who knows what.

However, asking questions was not merely an information-gathering tool. It served a more relational function within the organization that was observed on several occasions. When inquiries or problems were posed to others, it provided an opportunity, particularly when the interaction involved a power difference, e.g. between a project lead and an operations manager, to check-in and update the operations tier on progress or whatever else was happening with the project, or in the project lead's life otherwise. This relational maintenance practice played out often at water coolers, over meals, or before or after meetings.

Capacity for action. Lastly, an actor's capacity for action was realized as questions or situations were posed to those they perceived as being knowledge resources based on their identification. This capacity for action was also realized when individuals were redirected to another resource who could provide the insight needed to make a

decision or move forward on a project. Many times this capacity came from the simple deployment of information from one to another, allowing for a decision to be made in an largely determinate knowledge accomplishing episode.

Legitimacy of Action

The legitimacy of action resource involved addressing the issue of what was being expected of each person by their project team or the organization in general. As one corporate member commented during a conversation about the organizational structure and growth, "Learning takes place with consistent practices, otherwise it's just talented individuals." Establishing legitimate practice that reinforced and helped organizational members negotiate their identities and maintain levels of accountability through relational communicative activities was an important aspect of the organization's day-to-day practices.

Learning culture. The organization supported the learning-in-organizing culture through the implementation of what they called structured occasions, which were check-points and formalized processes along a project's life-span where key individuals would gather to process information, solve problems, and sometimes create new knowledge. A majority of these occasions were scheduled during the planning and initial phases of a project's life. Don, a project coordinator, who worked with multiple project leads, pointed out that during the estimating phase, he would meet with whoever was estimating the job and talk through some logistics and potential plan building ideas, so that there were some mutual understandings of the unique challenges the project posed and how those might be reflected in an accurate and competitive bid. He reflected,

> And then we get into the estimate and, and make sure that-- ultimately, the estimate needs to match a plan that could build the job, the, the labor, the equipment, everything in there needs to fall within certain boundaries of being able to build a job. Later on when that gets, if we secure the project, there's the turn over process, the planning process that, at that point, that the project team which that project lead and the coordinator are gonna work together and come up - finalize the plan.

By having estimators and project coordinators both talk through the estimate, each party could draw upon the other's expertise regarding building a thorough estimate or creating a realistic building plan. Their mutual knowledge was the key to securing projects that best matched that business unit's specialty and workforce availability. In this situation, the preconstruction lead understands the market and how competitive they need to be on the bid (among many other factors), and the project coordinator understands the embodied realities involved with constructing an object in a given space and the expertise the organization has available (or doesn't) to accomplish that task. These structured occasions were intended to reinforce the learning culture throughout the different levels in the organization and across the positions within each of those levels. While these occasions were most prevalent on a project by project basis, they did exist for some other positions that benefited from regular contact with others who might be able to bring insight, knowledge or simple information to a situation that was not available before.

One operations manager described a structured occasion that, while not necessarily a part of the project estimating, planning, or implementing phase, was an

activity that she and the other territory safety leads (TSL) from different regions in the country participated in on a bi-weekly basis. She described talking with the other TSL's during these bi weekly conference calls where they would update one another on their initiatives, problems they had encountered, or questions that they had which weren't necessarily pressing enough to have necessitated a separate conversation. These were important conversations for her and her TSL colleagues, as they would discuss,

> …what we're working on, any incidents that we've had, um, sharing knowledge about lessons learned, and how to avoid repeating our same mistakes. If OSHA shows up on one job and we're cited for one thing that carries across the board corporately, we need to spread the wealth and make sure everyone is aware of it because we don't want to repeat.

These calls allowed for quick navigation to the solutions of unique safety issues, as well as consistent contact and regular feedback from one another on their safety related initiatives. The group had created a community of practice from which they could pull knowledge or contribute their expertise as needed, which is an important structure for learning and knowledge management practice (Gherardi & Nicolini, 2002).

Relational communicative activities. The use of mentors was seen in the onboarding process for new hires or when someone assumed a new position in the organization. During these transitions, individuals were expected to create their own path in their new role, to take control of their career within the company, much like project leads when taking on a newly secured job. They didn't do it alone, however, as there was always a mentor assigned to work with that individual, to guide them through that

process, and help them learn what it meant to function in their new position and within the company if they were new to the whole process.

I had the opportunity to observe a meeting between a mentor and mentee, and it was clear that the mentee was struggling to keep up with his goals for securing new work for the organization. Part of this challenge was keeping abreast of the market in the local metropolitan area, and in order to do that, he needed to spend a significant amount of time reading local periodicals in order to discover information about potential jobs that the organization might want to pursue. His mentor suggested that instead of trying to accomplish this task in his office, which had large double doors with floor to ceiling glass panes, he should relocate out of office for those periods during his week in order to secure uninterrupted research time (the office around the cubicles were constantly bustling and shuffling with different organizational members, and some offices had more than one person in it, so it was often difficult to find quiet space and alone time to get this kind of work done). This simple suggestion came from an area lead, who was his mentor, as he himself had been in a similar situation and had found it to be useful.

Joe, an operations manager, described a time when he had not held up his responsibility to complete a knowledge check. Knowledge checks were a common relational communication practice that helped establish mutual understanding and legitimacy in planning and implementing. This activity also supported accountability resources that were an important relational component in many of the interactions taking place during project work. Joe recalled,

> And I knew that I didn't put enough effort into checking to make sure he had a plan…And, uhm, didn't ask "what are you hearing me tell you or what you -- what did you -- what have you decided…"…uhm, didn't ask those follow-up questions to the conversation to make sure we had a plan going out.

Another relational communicative knowledge management activity was referred to as "keeping it between the ditches." This involved hearing out a potential idea or solution, and without negating the work or expertise of the other, helping the other to recognize a potential downfall to the plan or proposed approach, hence keeping the plan or project "on the road" instead of "in the ditch." The nudge could also include suggesting a more effective, efficient, or otherwise more prudent approach that may help move the project forward, or steering someone towards a knowledge resource that may help inform their decision, plan or practice. This tool was used as a way of making sure that project leads and coordinators were not faced with a catastrophic impediment (that someone else saw coming), or (and this was more often the case) were aware of opportunities to help themselves conduct a more effective build, without taking away the decision making power, the buy-in, and the sense of agency that the organizational structure and structured occasions were intended to instill in the field and project tiers. This was essentially an opportunity for mentors, the estimator of the project, operations tiers, or other leadership to provide input and advice on the planning and implementation of a project. And while this type of feedback was often built into the planning phase of the structured occasions, it was also used as much outside of those formalized interactions as it was within.

An example of this came during a planning meeting, when a project lead, Phil, proposed that he over-dig a footing, because the plans called for insulation around the footing to help protect it from the destructive nature of the frost-line (freezing and thawing is one of the fastest ways to destroy the integrity of concrete). The operations manager asked him if he could instead place the insulation up against the dirt bank and pour the concrete up against that, which would eliminate the need for formwork and extra time. He suggested to Phil to "ask your Dad how he would do it." This is a great example of what the operations tier and other leadership folks referred to as "keeping it between the ditches." The operations manager wasn't going to interrupt the meeting to draw something out for Phil, when he knew that Phil's father might be a more readily available instructor for that type of knowledge. When the operations manager suggests that Phil seek guidance from his own father (a long-time veteran of the industry), he reinforced his own suggestion and simultaneously legitimized Phil's network of mentors and ability to learn from various sources by drawing on the known expertise of Phil's predecessor. So a small correction in the course of action, supplemented by a suggestion to reach out to another respected and knowledgeable individual, gave Phil the opportunity to learn a new process, and to have not one, but two sources of expertise to draw from as he attempted to implement the process later in the field.

Sometimes operations managers or other corporate personnel would recognize an opportunity to put two people together who could learn from one another. By recognizing expertise, and asking someone to share with another, the opportunity for learning was immense, as knowledge was being conveyed from one expert to a non-

expert, or between two experts who held different types of knowledge. In addition, experts could sharpen and hone their skill by teaching it, relaying it, or improvising with it, with another. This dual purpose learning opportunity was described by Joe, as he told me that an important part of their culture involves feeling comfortable being set up with someone who is more experienced to help show them the ropes, instead of threatened. He described the empowering feeling of this situation,

> You tell 'em, 'Man, ah, you're great at this and this person doesn't know anything about it. Ah, I'm gonna team this guy up with you and I need you to tell them everything you know…' And then they feel good about it, they're beating their chest, you know, that they're the expert, you know?

This practice further strengthened the network of relationships through communicative knowledge management practice of complimenting one another's expertise.

Capacity for action. Capacities for action were realized when legitimacy of the organizational practice was recognized, the organizational actor took ownership of that practice, and engaged in a self-directed mission to accomplish their task at hand, while recognizing and engaging other levels of the organization as needed (thus lending legitimacy to themselves and others' simultaneously). One pre-construction lead embraced his role and engaged in pro-active information seeking activities by creating a strong network of informants both inside and out of the organization. After being asked the same questions by his area lead about projects that they were targeting, he quickly devised a system for tracking what information he knew about the project, and what he needed to know before bringing it to his area lead's attention. He recounted how this

skill was a carry-over from a brief stint in a call center where he had a defined number of questions that he needed to have answered before he could hang up the phone. Developing a conversational skill that allowed him to gather his required information without sounding like he was firing questions off of a list was something that he adopted and honed through the years in his current role. He was able to call individuals he knew in his own business unit, other business units, or in other organizations to fill out his "filter sheet" by having informal conversations with them in order to gather the information that he needed. His position in the pre-construction and planning process was legitimized in the "filter sheet," as his capacity to act upon the systematically (yet conversationally) acquired information was recognized and reinforced by his coworkers who also adopted a similar practice, and from his area lead who no longer had to ask him the same 20 questions every time they reviewed a potential job.

Accountability

The framing resource of accountability complimented the identification and legitimacy resource as individuals or project teams looked to certain members of an audience for direction and validation. In this way, they were drawing on the identifications of themselves and others to predict the actions and interpretations of others while reinforcing their own identity as someone who embraced the legitimized practice of reaching out to their network to engage in structured occasions or self directed capacities for action.

Learning culture. The learning-in-organizing culture was promoted through the mutual accountability and mutual learning opportunities that took place during what

were called “turnover meetings.” These meetings consisted of pre-construction leads, operations managers and/or leads, and the project and field leads that would be responsible for carrying out the construction project. The meeting was well structured with an agenda that outlined the various responsibilities of each party. These turnover meetings would ensure that those who were doing the bidding and winning the jobs were able to accurately and responsibly pass the project and relevant information on to the project team who would be responsible for planning and implementing the contracted work. The operations tier team member would serve in a bridging function that would oversee the project from bid, through planning, throughcompletion.

Joe talked about how the culture has changed from an operations perspective, particularly as the economic environment has changed regarding this approach,

> We’ve continued to grow, uhm, it’s not a plan, organize, control, it’s a set -- set, uhm, set expectations, align resources, you know, motivate, inspire, all that stuff…is what we’re trying to do now. And get the project leads and field leads to plan, organize, and control their work, but still seek engagement from the craft and the people that are working around them to have the best plan possible.

Norm described how things are done differently than in other construction organization’s he’s worked,

> It’s their [the project leads’ and field leads’] job. It’s their job to…here is the roadmap, here is what you got, you build it how you want to build it. Then they reconvene, lay out their plan to the [operations] leads. So, that way, everybody is on the same page. If they identify any issues that maybe the estimator or whoever

didn't see and then, what's nice is then it's their plan, it's their involvement. They own it.

He went on to say,

It lets the team get involved with the job before it gets thrown in their lap and just say "Here you go. Go build it," …it makes sense to let the guys be part of the plan, you know. It's going to be their job. They got to be accountable.

This organizational structure supported consistent learning-in-organizing, where all project members would have the opportunity to provide their input and establish some ownership in the project.

Relational communicative activities. Accountability was a factor when projects came around that required the incorporation of the proposed project owners, other contractors and suppliers and upper-management in the bidding or planning process where they may not normally be so directly involved. This was the case when the project or issue was of such importance that all related parties needed to communicate what they knew about the situation in order to ensure each was fully aware of the risks and opportunities, as well as to verify the viability and competitiveness of the proposed work or solution and the roles and responsibilities of everyone involved. In other words, as the situation become increasingly indeterminate, accountability was a major focus during the communicative practice of accomplishing the knowledge work.

One project estimate was a priority for an area lead who was interested in securing the concrete work for a new public memorial structure that would be a prominent fixture in his metropolitan area. He described the project to me during our

first meeting, and over the course of my observations I had a chance to observe how they were utilizing different individual's expertise to put together a plan that they felt would put them in a good position to secure the bid. Doing so, however, was risky, because this type of job was completely custom, and as a result, the area lead told me "we could either totally lose our asses" or "be on the cover of a magazine". In this way the project proposal and bids were highly indeterminate, as there was no to little precedent to draw from when designing, bidding, and building a structure like the one that was being proposed. The area lead expressed to me that they were the perfect company to take on this kind of project, because they had the expertise needed to do the kind of custom concrete work the memorial was calling for. To demonstrate, he walked me into the office next to his and showed me a hand drawing on a whiteboard that illustrated how one of his operations guys had already designed a custom system for fabricating the formwork needed to create the unique radius shaped concrete walls. During a later planning meeting as they were finalizing a budget for the bid, I recorded the problem solving among the different attendees, which demonstrates the different types of knowledge that the area lead needed to include in the estimating process so that they were as prepared as possible to execute the project in a fiscally responsible way. It's important to note here too, that the area lead was indeed "running the show" on this project due to the complexity and the high value, high profile nature of the project. This break from the norm in terms of the typical structured occasion indicated that additional knowledge, legitimacy and accountability were needed to convey the value of the project to others inside and out of the business unit.

In attendance were the area lead, the office's pre-construction lead, and two operations tier individuals who had expertise in this kind of custom work and financially risky operation. Additionally, representatives from a formwork supplier they would have to work closely with were also in attendance, as the application would be unique and required everyone to be in the room together in order to communicative their unique expertise to form a well rounded bid. As the meeting got started, the formwork supplier was able to open a digital 3D model of the memorial, which provided exact specifications for the different material types, dimension, and other figures. During the meeting, the model was being displayed on a large flat screen television in the conference room that was hooked up to a laptop so that it could be manipulated as they discussed different aspects. An expert from the conversation went something like this:

> Area Lead (AL): (Points at a particular joint of steel meeting concrete) I do believe things like this can be addressed during the design phase.
>
> Operations Coordinator 1 (OC1): Your forms are sitting out half a year-what's that going to do to your forms, sitting out there in the weather?
>
> Formwork 1 (F1): You'll have to use new plywood for each pour, who do you have to get better pricing on that much plywood?
>
> OC1: The tighter the radius here, the more segmented the formwork will be, the more facing needed to make the smooth radius finish…
>
> AL: The mock-up [of the formwork system] will be in phase 2 of preconstruction, so before we finalize the price, we can do the mock-up. Sometime in March-May.
>
> OC1: The problem with that is that if we wait that long to do the mock-up and it doesn't work, we will need a fast tracked plan B.
>
> Operations Coordinator 2 (OC2): They know if they want a certain look, it will cost X, and if they want more than that it will cost Y.

AL: [to Formwork] We know you're not going to be able to get us a firm number, but if you can get a ballpark on what this will be…And we need to figure what the productivity on this will look like [looking to OP1 & OP2].

Formwork 2 (F2): We can figure out a unit cost on rolled whaler vs. custom whalers to help give you some options.

OC1: Is there any way to use a chamfer and grind it down instead of forming it up wrong? Since you're sandblasting the finish anyway?

OC2: why not a steel top plate?

AL: Do you know how much maintenance that would involve over 50 years?

AL: I'm more concerned with the panel seams. Even if we're pouring consistently during the winter and sandblasting it, if the concrete is a different color it won't change.

OC1: What about using a solid smooth panel that makes something like a 100 ft. run to cut down on panel joints?

F2: Then your costs really start adding up in materials and tools, and then it will change the surface of the concrete after the panel gets used a couple of times.

AL: Boys, we're not going to solve this, we just need to get an idea…

OC1: These base plates (pointing to screen) made of steel, how are they going to be integrated into the round wall?

F1: They're only 8" wide, so the wall should be flat enough

F2: Rolled whaler is a one-time purchase, instead of renting strait whalers for 12 months, so doesn't that start to narrow the gap a little?

AL: All we can do is price what they give us now, and through the later design phase we can present them with a reduced cost if they give us some more consistent radius across the project so we have fewer custom steel pieces.

F1: There is a new radius formwork system being developed in Germany right now—it uses a steel face with extremely strong magnets…

AL: again, for now we're just providing a budget…I also want you guys [F1 & F2] to figure in the cost of having someone on-site for a month or so, if we're getting in a

> new system, we need someone on-site for a while to help us learn how to use it properly.

The conversation wraps up with the promise to track down more information on the new system being used in Germany as well as some more accurate numbers for the options that were being discussed. What is interesting about this interaction was that there were no real solutions determined at this point. Different types of expertise were brought to the table that allowed the group to identify several important issues that needed to be looked into. By having the available knowledge resources together in the room at the same time, looking at the same high quality 3D model, a significant amount of progress was made in terms of moving the bid forward, even if it doesn't appear that way at first glance. This meeting also served to reinforce the relationship between the concrete contractor and their equipment supplier who wanted to be involved in the project and could bring some unique solutions to the table, thus adding value to the bid and creating a capacity for action to complete the bid process (or decide that the project would ultimately not be a good fit for the location, which was the result for this particular situation). Regardless of outcome, the practice of engaging all related and necessary constituents in opportunities to mutually define each other's roles and courses of action allowed the project to move forward, the organization to learn in their practice, and individuals to gain useful experience and relationships that could serve them in later knowledge management actions.

Capacity for action. A capacity for action was realized when expectations were being met by those involved in a project. This meant that pre-construction through field operations, and at all levels of the organization, mutually negotiated and defined

responsibilities were being carried out as all held one another accountable for their respective roles. Not unlike a transactive memory system where each member counts on well defined knowledge domains of others. Outside vendors, fellow sub-contactors, and owners or development companies all relied on one another to perform their knowledge work within and amongst one another. I'll illustrate this last practice by providing a counter-example of when the system failed to provide opportunities for communicative knowledge management activity, and subsequently required a different capacity for action that was atypical (and ultimately a different opportunity for communicative knowledge management activity).

Sometimes the appropriate audience members can't include individuals who would normally be a part of that accountability resource for a particular project. One project manager had to learn how to keep the knowledge management activities at a lower level in order to prevent the customer and the customer's operations level management from participating in the problem solving process, because they became too difficult to improvise with. When confronted with this situation, James come up with a different accountability capacity for action that worked in the favor of the sub-contractor's project managers who needed to cooperate in order to move the project forward in a timely manner. James told the story,

> Yeah, it was actually a weird situation…So with someone who does not want to budge, you usually elevate it. You know, you go to their supervisor or you go to the -- the director or executives. Well, in this particular case, the director and the executives were -- were the problem. So what I decided to do, uhm, was do as much

> as I possibly can to resolve all issues in the field. Do not let them, ah, grow, ah, to -- to that elevated position because once they did, it would -- it would not, ah, resolve in a good way for either party…including the customer. So, in that case, which was a weird phenomena, I've never seen that anywhere, I, ah—I…we [sub-contractor project managers] were all trying to fix it – we were trying to fix it where -- where -- where -- where it started. And, ah, that worked.

James could only rely on himself and his project manager counterparts to work things out together, because they could not rely on the upper-management level to effectively manage disputes or problems. James' story indicates an important characteristic of knowledge work in the construction industry. When coordinating knowledge among a diverse group of experts who hold their own subjective views regarding the best path forward, one must be prepared to manage those communicative accomplishments in a way that provides opportunities to move in a desired direction, and not get stuck in the pandering that many construction professionals despise about such complex coordination activity.

Discussion

The Communicative Practice and Accomplishment of Knowledge Work

The interpretive analysis and framework for practice based research and knowing (Kuhn & Jackson, 2011) outlined intersections of three situation framing resources that all contributed in overlapping ways to the ability of the company and its partners to communicate and manage what they know. In so doing, this investigation has captured some practices in which a learning-in-organizing culture was promoted through certain

well defined relational communicative knowledge management activities (along with others that were less well defined). These activities ultimately led to various capacities for action where organizational members and teams were capable of moving forward when challenged by the project, the environment, or other humans involved in the construction of their product. It also appears that the organizational structure which consisted largely of smaller unit sizes within each business unit, and team based organizational structures allowed for a pseudo transactive memory system that relied on developing expertise directories and retrieval of information from particular knowledge experts when they were recognized. This provides some important examples of the daily communicative activities that facilitate the coordination of knowledge and expertise in response to the first research question (*What are the daily communicative activities that facilitate the coordination of knowledge and expertise in a project based organizational structure?)*.

In terms of research question two (*How is relational knowledge management practice related to cultural organizational learning in the project based construction organization*?), these findings are also a clear indication of the interrelated nature of a learning-in-organizing culture and the importance of relational communicative knowledge management activities. The encouragement of the use of questions for all levels of the organization, the assigning of mentors and mentees to develop structured interactions between organizational members at different levels of tenure, the utilization of different forms of expertise to complete projects when needed, and the incorporation of relevant outsiders in the problem solving or planning processes all created structured

relational communicative practices that aided the organization and individuals in their ability to communicate with one another in order to realize capacities for action.

Agendas for project planning and turnover meetings even went so far as to indicate that "Team members (and any observers) provide constructive feedback to the participants as to the quality of the meeting." The necessity of engaging feedback was an important practice for Constructors in much of what they did. It signified a relational culture that valued individuals' contributions and believed that all members are needed to participate in the process. It also indicated that no one person or team was capable of understanding or knowing all of the answers, and therefore, there were some differentiation in the knowledge domains among organizational teams and business units, providing further evidence of the potentiality of a conscientious transactive memory system (Palazzolo, 2011). Relational communicative knowledge management activities certainly contributed to the learning-in-organizing culture by promoting social engagements in particular contexts (structured occasions, team planning opportunities, or working with outside vendors to design a bid, plan or complete a project) where learning could take place.

The relational communicative activities also served to create and reinforce the image of individual responsibility. While there were resources available to team members to help guide them through their work, it was often communicated that each person needed to embrace a self-directed approach. Working to get by, and not taking advantage of the opportunities at hand were not rewarded by the organization in the form of new responsibilities or promotions. This served the semi-transactive memory system

well, in that most organizational members were willing and able to maintain their own form of expertise and unique knowledge, and some even leveraged those positions to demonstrate their value to the organization.

Organizational Transactive Memory

The pseudo-dispersed nature of the organizational structure and design seemed well suited to take advantage of a differentiated transactive memory system, however the organization never really made it a goal to establish unique knowledge experts. The exception was the safety program where they named and trained Subject Matter Experts, or SME's. These SME's would be trained in particular safety areas (e.g. rigging and signaling or forklift operation). The SME's would then be identified on the jobsite by unique, easily identifiable markings (in fact the organization was discussing new ways to create easier visual identification methods for SME's on site). This relates to Palazzolo's (2011) description of NASA's Team X, who operated a multidisciplinary team of scientists to quickly vet mission concepts by creating prototypes, timetables and budgets for entire proposed missions in one week. This team relied on very distinct knowledge domains, and according to Palazzolo (2011), they would even clearly write their knowledge domains at their work stations in order to easily and efficiently be able to identify the needed expertise in the moment, without having to rely on knowing which person, or temporary person, was responsible for propulsion knowledge that day. By quickly demarcating knowledge domains, like rigging and signaling on the construction site, the organization is better prepared to remain flexible or deal with turnover as

different individuals with similar expertise can be moved in or out of the project as needed.

Most other identification or communication of information or knowledge, however, happened on an ad hoc basis (who was the closest or first available operations manager who might be able to answer my question?), or in structured occasions where the organization or business unit had identified the parties that needed to be involved (and due to material issues like work-load, availability, or personal reasons, the project team designations weren't always based on the domain of knowledge or expertise held by each individual, but instead of who was available or who could get along with person X).

In an interesting potential extension to transactive memory systems, it did become apparent that certain business units were more knowledgeable than others regarding different kinds of projects. The organization even had verbal designations for three interrelated but different building types. When describing a project that was largely structural in nature (columns and beams, support decks, etc.) they would refer to it as Z work, whereas slab-on grade or tilt-up projects (warehouses and other large flat concrete pads and walls) would identified as X or Y work. Certain business units were known for doing a lot of Z work, for example, and individuals from other business units might contact them if they came across a Z type project that they weren't as familiar with because their business unit typical dealt with Y projects. This also played out on the business unit level to a certain degree as well.

For example, one operations manager was always consulted on tilt-up warehouse projects. That was his "bread and butter," and he was known among many business unit members as holding that expertise. In this way, a pseudo transactive memory system was at play at both the business unit and organizational levels, although much of the knowledge management communication failed to update those identified experts when new knowledge or information came to light related to their unique domains. Information updating was a low priority in most relational communicative activities.

The Framework for Practice-Based Research on Knowing

Kuhn and Jackson's (2008) framework for practice-based research on knowing was successful in it's ability to organize the essential elements involved with problem solving in a meaningful and fruitful manner. This investigation was able to highlight how organizational learning and relational communication interact during the communicative accomplishment of knowledge work in a construction organization. One thing, however, became apparent through the analysis that might help more clearly and precisely explain the level of determinacy in a given situation. A fourth situation framing resource, embodiment, appeared, at least in some situations, as needing to be negotiated during knowledge accomplishing episodes.

By embodiment, I'm referring to the claims made by individuals and teams regarding physical possibility, that help to shape judgments of appropriateness when dealing with solving material problems. The situation framing resource of embodiment relies on one's previous understanding of how materials, both natural and made-made, interact in a given situation to allow or constrain possibilities. These material

possibilities are subjective and rely on absorptive capacity, or previous physical experience with those materials and environments (Szulanski, 1996), in order to supply certain interactional claims on activity. An example of an actor negotiating the situation framing resource in an indeterminate situation might sound like: "I've felt how heavy this panel system gets after repeated use, and it would be prohibitive to use this system on a steeply sloped, difficult to access job site like the one we're looking at. I would suggest spending the money on a lighter-weight system and save time and the health of the crew." This statement and suggestion relies on the actor's previous expertise handling the panel forms after repeated use, where concrete and form release oil have added significant extra weight to each already heavy piece. Sennett (2008) describes the distinction between the head and the hand as being both an intellectual and a social one. In other words, legitimacy of one's physical know-how is often less valued in the traditional "knowledge economy," but when dealing with craft, that changes significantly. Individuals in Constructor's were sought out for their perceived craftsmanship, as they were perceived as having the right *kind* of expertise needed to solve potential problems on the ground.

This additional situation framing resources helps actors make claims about appropriateness of action in the same way that identify, legitimacy, and accountability do. Granted, there are overlaps with these other resources, as our identity in the construction industry, for example, may be largely tied to the physical work one is capable of in the field. But identify framing resources don't totally encapsulate the importance and value of embodiment when solving problems in a construction

organization. Take for example, the situation described previously with the preconstruction lead and the project coordinator who relied on one another's embodied expertise to help ultimately move forward on a project. A preconstruction lead needs to understand how a project will work both conceptually and physically, but he or she also relies on the project coordinator, who is often chosen specifically to manage a project because of their previous expertise (i.e. absorptive capacity), to help frame any problematic situations using their embodied know-how. It was common to speak with project leads, who had degrees in construction management or construction engineering, who found that they were unable to perform their jobs in the office, because they could not adequately understand the problems that were being faced in the field by the craft without any previous experience in those environments. As a result, many of these new graduates would opt to spend a few years working on site as a project lead before returning to the project coordination or preconstruction side of the process. The understanding of the interaction of physical resources is an important situation framing resource that should not be ignored in Kuhn and Jackson's (2008) framework for practice-based research on knowing, as it has important implications in the communicative accomplishment of knowledge work as it pertains to sectors like construction.

What's Missing?

Some points of interest should also be noted by recognizing what was not observed during my time with the organization. Even though learning was highly valued at both the individual and organizational/business unit level, there was a lack of clear,

unified practice for maintaining a consistent information technology system within the business units or even company wide. Many business units had intranets that allowed them to store information from old projects, and some even maintained their own databases of information and documents that they could refer to when coming across something they were uncertain about. However, outside of their knowledgeable application, the information was less than accessible for newer or less-experienced organizational members who would have a hard to making sense of the data located on some of those dispersed data bases. This might indicate, perhaps, a greater reliance on personal communication including things like dialogue, answering questions, and the use of story-telling to pass on organizational knowledge (Bartholomew, 2009; Marwick, 2001).

The only exception to this observation was a SharePoint system that was available organization wide. It was commented on by several organizational members (mostly at the corporate level) as being unwieldy and overstuffed with old, unnecessary documents that were no longer applicable or approved for use (apparently no one really knew what was on the document sharing site, and there wasn't any one person who was responsible for it's maintenance). Safety implementation pages, however, were kept in order and managed regularly to ensure that those materials were consistent, accessible and useful, organization-wide. This work was being conducted by the group of territory safety leads who were each responsible for engaging all levels of the organization in safety related work within their own territories. These TSLs provided one example of the organization working to engage vertical communicative practice that was consistent

throughout the tiers of the organization. This perhaps supports Peltokorpi (2014) when he indicated that team based structures need vertical mechanisms to coordinate organizational level TMSs.

Similarly, there was also a conspicuous lack of follow-through with many organizational learning outcomes. While there were consistent levels of feedback sought as the organization or individual business units engaged in new practices or implemented new policies, there were no standard review formats for completed projects, at least among the business units I observed. Learning was fostered, for example, when the organization began using a daily planning process (DPP) on all of it's job sites. The practice was conceptually and practically well developed, went through continuous edits as the organization learned how it's project team members were using it, and adapted it to fit their needs until it was a relatively well accepted part of each project team's daily routine. The outcomes of projects, however, and the "lessons learned," where never really captured or discussed outside of the use of stories to pass along experiences among organizational members. This is not uncommon among domestic construction companies (Carrillo& Chinowski, 2006), but it does indicate a missed opportunity (Bartholomew, 2009).

Conclusion

This study suggests that relational communicative knowledge management activities are largely used to support learning-in-organizing during the negotiation of framing resources like identification, legitimacy, and accountability. Whether the problem is big or small, the project is custom or old-hat, a construction organization's

ability to communicate what it knows both within and outside of it's walls is a valuable skill. Some structured practices help to formulate interactions that can support the communication of tacit, or sticky knowledge, and other times organizational members need to rely on one another to check-in, ask questions or relay a story that might help each other move toward a goal or solve a problem.

Practical Implications

This study highlights a few practical implications that may be relevant for other project based organizations. First, these data provide further support of the ubiquity of knowledge and knowing in the organizational setting and the value it may have when attended to through the structural and cultural dimensions of the organization. Creating opportunities for relational communicative knowledge management activities through communicative practices like structured occasions could serve many project based organizations well. Replicating some of the practices seen by the safety components of Constructor's SMEs and TSLs may prove prudent to a functional organizational transactive memory system. Information and knowledge is replicated across the system, but at a scaled level where the right knowledge is available to individuals in a face-to-face manner by quickly identifying the team member on the job-site, in the office, or among the business units that can provide access to a larger community of practice who may be able to help address the question or problem at hand.

Theoretical Implications

This study adds support to the idea that project based organizations who experience unique knowledge challenges, particularly in the construction industry, must

rely on the subjective, action oriented and highly relational nature of knowledge work in order to achieve capacities for action (Kuhn & Jackson, 2008). Additionally, this investigation provides an example of a practice-based view of the communicative accomplishment of knowledge as it played out among three interrelated business units in the construction industry. As a result, further evidence of the utility of the practice-based view when investigating knowledge work has been provided through the use of a complex methodology and the engagement of similar concepts in comparison to other investigations of communicative knowledge practice (addressing a common critique of the practice-based view identified by Kuhn and Jackson, 2008).

The results of this investigation adds a caveat to extending transactive memory systems to the organizational level. These results indicate that transactive memory systems may not function wholly as such across organizations or subdivisions like business units. Important factors like materiality, time and and valuing the knowledge work involved with important steps like updating the knowledge directory may hinder an organizational wide memory system from being updated and maintained regularly. Instead, as in this organization's case, there may be stand-out individuals or even project teams who are known for their expertise and knowledge. These individual or teams, however, may or may not be involved when needed due to a lack of time, convenience, or even because of the cost associated with traveling to meet face-to-face.

Lastly, this research has identified a potential fourth situation framing resource that should be considered in Kuhn and Jackson's (2008) framework for practice-based research on knowing. The framework was used to add specificity and clarity to an

analysis of the communicative accomplishment of knowledge work. Particularly in this context, it appears that embodiment may serve an important framing role in knowledge accomplishing episodes, where individual's absorptive capacity becomes a valuable position from which to engage in knowledge work. Future research should more fully consider this additional situation framing resource and it's role in Kuhn and Jackson's framework.

Future Research

Regarding transactive memory systems, an important point was made about how certain individuals are identified or recognized as holding a particular form of relationship, or holding a skill that allowed them to manage a relationship in a particular way. This wasn't a "know what" or a "know how," but instead a "know who" or maybe a "know how to manage a who." If the company needed a "bulldog" for example, to get a project back on track through the use of a highly disciplined and "no bullshit" approach, certain project leads or managers, or operations tier individuals would be called upon to accomplish the specialized task at hand. Much like the TMSs, ("who knows what" becomes "who knows whom") information updating still takes place as other organizational members update that relationship expert on happenings and goings-ons related to their relationship domains, and their relational expertise is then retrieved or called upon when the situations warrants their relational style or previous relationship status with important project members. For example, I witnessed an on-site meeting between a project owner and an area lead from a different business unit than the one that was completing the project. The meeting had been arranged to take place in person, with

a different area lead than who was technically responsible for the project, because of the relationship that existed between the outside area lead and the owner. The owner had done many projects with the outside area lead, and this was their first project in conjunction with the new area lead, new crews, and somewhat different way of doing things. The outside area lead was there to serve a bridging function, to ensure that the relationships between two organizations remained successful. Further investigation of this transactive relationship system is needed to determine if it does indeed function similarly, and if so, how the the organization can manage those systems to their benefit.

Limitations

Certain limitations should be recognized with this research. First, less than a third of Constructor's business units were included in the data collection. This represents a small portion of the overall organization network of knowledge and expertise. In addition, the three locations that were included in this study were well acquainted with one another, and all were closely associated with the president of the organization, meaning there might have been more influence on their cultures than in other units located further away, who had also been more recently established (one of the business units was the original location of the company from which it has expanded). Also, 20 days is a limited amount of time to spend with an organization, particularly across three different organizational sub-units. Additionally, the nature of interpretive research means that these findings are not necessarily directly generalizable to other construction companies, as these data and analysis are only snapshot of how one company communicates what they know. Also, having worked in the industry prior to this

investigation, I have experienced the conversations, interactions and interpretations through my own perspective. This influenced in particular choices that have been made in terms of the analysis and conclusions, and while this is also a benefit to the rich data that I was able to collect in a short period of it, it needs to be acknowledged none the less.

CHAPTER IV

THE STATE OF KNOWLEDGE MANAGEMENT IN THE DOMESTIC CONSTRUCTION INDUSTRY AND ITS EFFECTS ON PROJECT OUTCOMES

Introduction

The construction industry has generally been slow to catch on to knowledge management and other practices that may help develop a culture focused on learning and connecting new ideas in order to meet the needs of customers, investors and other stakeholders (Duboise & Gadde, 2002; Styhre, 2009). Simultaneously, the industry is wrought with unique challenges that provide opportunities for advanced tools and techniques to be utilized. There is ample research supporting the multitude of issues facing the construction industry and their ability to keep pace in innovative capabilities (Drejer & Vinding, 2006; Dubois & Gadde, 2002; Styhre, 2009). As a result, the industry suffers from chronic delays, inflated budgets, and consistent underperformance in terms of quality and customer satisfaction (LePatner, 2008).

The same industry is responsible for the largest human made structures in the world. As such it has also been responsible for some of the largest projects on the planet, and subsequently, some of the costliest mistakes and overruns as well (e.g. Boston's Big Dig project came in roughly $13bn over budget). The domestic construction industry ranked second in the world in size in 2013 (Kandan, 2014; Global Construction 2025, 2013) and accounted for over 960 billion dollars worth of new construction put in place over the course of 2014, or 3.7% of our national GDP (U.S. Department of Commerce Bureau of Economic Analysis [BEA], 2015). The domestic construction industry

employed 7.3 million Americans in 2013 and accounted for $3.25 billion in wages and salaries (BEA, 2015). These numbers point to the enormous influence the industry has in our economy and daily lives.

The architecture, engineering, and construction sector also faces a daunting list of unique challenges that contribute to its relatively limited innovative capacity, which makes the sector a prime candidate to benefit from the conscientious practice of managing its intellectual resources more effectively (Styhre, 2009). These challenges involve the fragmented nature of the industry (Dubois & Gadde, 2002; Styhre, 2009), the novelty of each project (Emmitt & Gorse, 2007; Kazi, 2005), the geographically dispersed nature of the organizations (Sole & Edmundson, 2002; Zorn & Taylor, 2004), the common conflicts of expertise (Rooke & Clark, 2005; Styhre, Josephson, & Knauseder, 2004), and the often extreme time pressures associated with these types of projects (Fong, 2005). Most importantly, due to the short-term nature of the project-based organizational structure, construction companies consist of tight couplings when involved in individual projects with other contractors and craft, but are generally loosely coupled when it comes to the permanent network of actors that are involved with the overall construction process (Dubois & Gadde, 2002). As a result, construction organizations are challenged to maintain efficient operations as they favor short-term task objectives over long-term knowledge development and use (Bresnen, Goussevskaia, & Swan, 2004).

Considering the industry's poor performance reputation, the relatively slow adoption rate of knowledge management practice among domestic firms (Carrillo &

Chinowski, 2006) and the potential benefits that knowledge management has to offer (Yang, Chen & Wong, 2012; Zheng, Yang, & McLean, 2010), this study attempts to better understand the current state of knowledge management use in the domestic construction industry, the driving forces behind the adoption of such practices and finally, the influence of that adoption and use on project outcomes.

The goals of this research then are three-fold. First, a general analysis of the current state of knowledge management (KM) practice will be done in order to gain a better sense of how construction firms in the U.S. are thinking about and utilizing KM. Second, an investigation of the underlying factors involved with KM adoption among domestic firms will be conducted in order to better explain why organizations adopt new practices. Third, the relationship between KM adoption and ultimately the use and effectiveness of KM practice on project outcomes will be tested to provide further support for the efficacy of the communicative power of KM in the construction firm. In order to do so, this chapter will focus on the description, analysis and discussion of a nation-wide survey aimed at the top management of construction firms. The following review sections will explain what is known about the current state of knowledge management practice in the domestic construction industry and conceptualize knowledge as an organizational resource.

Relevant Literatures

The Domestic Construction Industry

Relatively little research has been conducted in the United States regarding knowledge management practice in the construction arena. Many organizations are still

trepidatious about the incorporation of dedicated knowledge management systems (KMS) or tools that may allow the organization to perform at a higher level, or at the very least, help to maintain organizational know-how in a competitive market. The domestic sector has been compared to that of the United Kingdom's, and in the past the U.S. has been fragmented in their recognition and adoption of knowledge management systems or practices that move beyond the reactive retrieval of stored data (Carrillo & Chinowski, 2006). Carrillo and Chinowski summarized that, while the U.S. industry has appeared to recognize the potential for KM, it was much slower in their recognition of useful steps to take in order to actually manage that knowledge. For example, half of the 30 construction organizations reported in their research employed a systematic after project review process in order to capture lessons learned, while 67% of the organizations reported that they reactively changed organizational practices after a problem was recognized instead of when knowledge demonstrated that a better option existed. About 50% of the organizations studied did not employ any sort of system where individuals could exchange ideas or request input from others in their technical area, (i.e. communities of practice) (Carrillo & Chinowski, 2006).

It's important to understand the current state of knowledge management practice in the domestic sector because firms' ability to communicate what they know ultimately effects their ability to solve problems and improve the overall effectiveness of the industry. Knorr Cetina (1996) argued that knowledge and knowing is infrastructural rather than additional, meaning it lies at the very heart of society's and the economy's (and thus the firms') ability to function. Styhre (2009) added that knowledge then is the

single largest factor in determining market competitiveness. Because construction has received little attention from this theoretical perspective, its time to take stock of how knowledge work is accomplished communicatively in this context (Canary & McPhee, 2011; Styhre, 2009). In order to do so, a broad survey of the construction industry is needed.

First, Canary & McPhee (2011) argued that knowledge work is valued differently in different contexts, meaning that even within the larger architecture, engineering and construction sector, knowledge may be conceptualized and valued differently because of the nature of work and differences in cultures, resources, and markets. Abroad, construction and engineering firms have largely recognized the value of knowledge management as an organizational resource (Carrillo, Robinson, Al-Ghassani, & Anumba, 2004; Forcada, Fuertes, Gangolells, Casals, & Macarulla, 2013). Carrillo and Chinowski (2006) were limited in their reporting of the broader domestic landscape because their goal was to see if there was a clear distinction between engineering and construction firms, and indeed there was higher emphasis on knowledge sharing among engineering and design firms than in construction organizations, lending further support to the idea that knowledge is used differently in different markets and contexts. This means we have limited understanding of the current status and prevalence of KM practice among domestic firms. By focusing on construction firms, this research is interested in better understanding how domestic construction contractors, who appear to have the most to benefit from new knowledge management practice, are conceptualizing, using, and advancing from it. This study will help to update what we know about the

domestic construction industry by answering the first research question: *To what degree do domestic construction organizations value knowledge management?* It is one thing to understand the value and potential of managing the intellectual resources of the firm, and another to actually attempt to leverage it.

Second, the obstacles to implementing and continuing knowledge management activities can be numerous. A focus on short-term outcomes (Bresnen, Goussevskaia, & Swan, 2004) over long-term learning which is largely related to high time pressures to complete projects (Fong, 2005), means that efforts to manage knowledge and know-how can easily become a second level priority. Carrillo, Robinson, Al-Ghassani, and Anumba (2004) found that a lack of standardized work processes (i.e. little to no coordinated effort across projects and dispersed organizations, or a lack of a coherent knowledge management *system*) and organizational culture (i.e. individual business units and silos prevented communication and the flow of expertise and know-how among relatively distinct organizational components) were among the most significant barriers to communicating knowledge among the U.K. firms they surveyed. Forcada, Fuertes, Gangolells, Casals, and Macarulla (2013) also found that culture, time, a focus on individual rather than team effort, and a fear of sharing what one knows were significant obstacles for the construction and engineering firms surveyed in Spain. Forcada et al. (2013) argued that these barriers were common among all industries, and therefore were not unique to construction. This study will attempt to determine if those barriers are still indeed the major hurdles to implementing and carrying out KM systems and practices

among domestic firms through the second research question: *What barriers impede the development of knowledge management in the organization?*

Third, strategies or tools used for KM purposes typically fall into technological and non-technological categories. Technological KM tools include email, intranets, internet, database systems, document management systems, electronic discussion forums and sometimes specially designed KM software (Carrillo, Robinson, Al-Ghassani, & Anumba, 2004; Wetherill, Rezgui, Lima, & Zarli, 2002; Woo, Clayton, Johnson, Flores, & Ellis, 2004; Yin, Tserng, & Tsai, 2008). In the past, there has been an overreliance on short-term technologically based tool use that appears to have failed in many cases to provide the driving force needed to realize organizational benefits through their implementation alone (Bartholomew, 2009; Quintas, 2005). These technological tools can be more useful, however, in conjunction with non-technological KM tool use, including communities of practice, conferences and seminars, small group meetings and brainstorming sessions, training and education plans, using consultancy, and focusing on building relational routines and coordination that allow for more face-to-face communication and problem solving systematically (Forcada, Fuertes, Gangolells, Casals, & Macarulla, 2013; Fu, 2015; Yang, Chen, & Wang, 2012). When combined, the technological tools can serve as valuable information repositories or interfacing opportunities that allow larger firms to reduce the distance between project members (Carrillo & Chinowski, 2006). This informs the last research question: *What tools are being utilized to implement knowledge management strategies?*

Addressing these research questions through the use of a nationwide survey of knowledge management practice will help to provide further insight in the advancements that the industry has made in recent years. Another goal of this research is to better understand how knowledge management practice affects organizational outcomes. In order to address this goal, a resource based view of the firm (Jackson & Williamson, 2011) is needed to conceptualize knowledge as an organizational resource which may be susceptible to management and improvement.

Knowledge as an Organizational Resource

The knowledge economy is based upon the value of individual or group know-how and wherewithal. The management of knowledge is the active cultivation of know-how as an organizational resource in an effort to gain competitive advantage and promote new, innovative work practices. The goal of adopting new KM processes among construction firms is to realize increases in organizational effectiveness and competitive advantage (Robinson, Carrillo, Anumba, & Al-Ghassani, 2004). Because knowledge lies within the individual and is constituted in our relational communication (Bartholomew, 2009; Bresnen et al., 2003; Brown & Duguid, 2002; Styhre, 2009) the management of that knowledge should be considered a strategic asset (Bollinger & Smith, 2001; Egbu, 2004) directly related to organizational communication (Canary & McPhee, 2011).

Those outside of the construction industry have leveraged knowledge management practices for some time now (e.g. Unilever, as described by von Krogh, Nonaka, & Aben, 2001). Adenfelt (2010) found that knowledge sharing, through

frequent communication and coordination, was a significant factor for project success in a case study of an international project management team. Few research findings, however, have connected knowledge management communication to project success in the architecture, engineering and construction sector; those that have, found that knowledge management was a significant factor in a firm's ability to be successful. Knowledge management activity was discovered to fully mediate the relationship between information technology use and project success factors and project benefits (e.g. schedule, cost, quality and safety outcomes) (Yang, Chen, & Wang, 2012). Chen and Huang (2009) found that knowledge management capacity (knowledge acquisition, knowledge sharing, and knowledge application) served a mediating role in the relationship between strategic human resource practices and innovative performance.

The organizational outcome of concern for this investigation is the degree to which organizations were successful in realizing *project benefits* through their work. Project benefits are not necessarily financial, safety or schedule performance on a particular project, although they maybe largely related to these outcomes. Instead, project benefits involve how successful the firm is at exceeding customer and/or owner expectations while realizing comprehensive above average performance results. Customer satisfaction is valuable to organizations who rely on repeat customers and reputation to win bids in a largely subjective award system (LePatner, 2008). Realizing exceptional project results also benefits the organization's culture and reinforces a positive self-concept or identity as a high performing firm. This is a more comprehensive and difficult outcome to replicate or achieve when compared to pure

performance measures like budget or safety performance, making it an indicator of strategic resource use. Strategic resources, at least truly market defining competitive resources, are not only valuable and rare, but also inimitable and non-substitutable (Jackson & Williamson, 2008). Achieving exceptional results indicate that the unique knowledge resources of the firm are both difficult to replicate (inimitable) and incapable of existing outside of the unique environment and context of the firm (non-substituable). Being able to realize these kinds of project benefits also involves specific knowledge management tool use.

In order to realize beneficial project outcomes that help establish market competitiveness, knowledge must be managed strategically within the firm. This means that *knowledge management tools* are incorporated in the organization's day to day activities in an attempt to leverage their human intellectual resources. As previously discussed, these tools come in information technology and non-information technology forms. Information technology tools like intranets and extranets, document management systems, data bases and the like have long been associated with effective information management that can support systematic knowledge management processes. Communication scholars have argued that information communication technologies' "representational and connectivity capabilities should not be seen as equivalent to knowledge creation, learning, and transfer. The latter are primarily socio-material practices, not merely technological construction" (Tsoukas, 2011, p. xviii). This means that non-IT tools must accompany those technological options in order to allow for relational interactions which have been shown to improve other organizational outcomes

(Fu, 2015). Non-IT KM tools include processes or opportunities for individuals to interact and problem solve. A resource based view of the firm relies on the relational capacities of organizational members (Fu, 2015). Non-IT KM tools like communities of practice (Gherardi & Nicolini, 2002) help to develop a culture the promotes sharing, acquiring and implementing knowledge through relationships that may not be hierarchical or merely interpersonal. Small group meetings and training and education plans are popular among construction and engineering firms for knowledge management purposes (Forcada, Fuertes, Gangolells, Casals, & Macarulla, 2013) and provide opportunities for face-to-face interactions. These face-to-face interactions are important as they allow for the knowledge accomplishing episodes to take place, where existing knowledge may be deployed or new knowledge may be developed, depending on the needs of the problem (Kuhn & Jackson, 2008).

Additionally, an organization's capacity for knowledge management is determined by it's perception of certain *knowledge management obstacles* (Forcada, Fuertes, Gangolells, Casals, & Macarulla, 2013) that prevent the implementation or efficient use of *knowledge management tools* (Egbu, 2004). A knowledge management obstacle is any perceived barrier to the implementation, use or updating of a potential or existing knowledge management tool or system. Forcada et al. (2013) argued that these barriers are common across industries, and so some of the most significant obstacles to knowledge management are cultural or material. An organization whose culture does not value knowledge management can indicate a lack of shared vision and unified involvement form top to bottom, and either a fear to share one's knowledge, or

knowledge hoarding as a result of a "knowledge is power syndrome" (Egbu, 2004). Material factors can play a large role as well. If an organization doesn't commit the time and financial resources needed because of a focus on short-term goals or because of a lack of proved KM tools, KM initiatives have little chance of succeeding (Carrillo & Chinowski, 2006; Forcada et. al, 2013). With the numerous obstacles to the successful implementation of knowledge management, there must be significant motivation for organizations to recognize the potential in knowledge management, and then be willing to commit the time and effort needed to overcome those barriers.

Adoption of Knowledge Management Practice

Implementing a new knowledge management (KM) practice or tool may be spurred on by more than the need for getting the right knowledge to the right place at the right time. There are often institutional factors at play when sectors adopt new tools and technologies (Zorn, Flanagin, & Shoham, 2011). The adoption of new, innovative capacities like knowledge management systems (KMS) or information technologies within an industry typically follows a predictable s-shaped pattern. Early adopters slowly contribute to a growing industry awareness that leads to a spike in adoption. This accelerated adoption rate eventually levels off as the new practice or tool becomes an industry standard (Rogers, 2010). Organizations adopt innovations largely because of characteristics of the organization and environment, or because of perceived benefits and advantages of the innovation itself (Flanagin, 2000). Beyond that, however, Flanagin (2000) argued that organizations also adopt innovative practices because of certain social pressures. The social pressure to adopt new practices is considered a mimetic

institutional pressure, where firms adopt the *expected practices* of organizations they see as similar to themselves (Zorn, Flanagin, & Shoham, 2011).

Institutional pressures are an important component of predicting and understanding KM adoption among domestic organizations. Because this industry is so important to the domestic and international economy, it becomes valuable to understand how the trends in the sector are shaping firms' ability to respond to competition. In order to do so, it is necessary to assess the institutional pressures that motivate individual firms to adopt new KM capacities, and how that adoption effects organizational outcomes. One way that previous research has established empirical relationships between KM and project success is by measuring the degree to which projects produce *organizational benefits* like exceeding customer expectations and producing excellent results (Yang, Chen & Wang, 2012). Because organizations adopt new practices, at least in part because of expectations for benefits, the adoption of KM practices as a result of mimetic pressures should also lead to increases in organizational outcomes. Thus, the following hypothesis is posed:

H1: The institutional pressure of the expected practice to adopt knowledge management (*EPKM*) will increase project benefit outcomes.

Based on Yang, Chen, and Wang's (2012) findings regarding the effect of knowledge management on project benefits, and the role of obstacles and tools as significant factors in a firm's ability to engage in and realize benefits from knowledge management (Chen and Huang, 2009; Egbu, 2011; Forcada, Fuertes, Gangolells, Casals, & Macarulla, 2013), the following hypotheses will be tested. First, the effect of the

mimetic institutional pressure to adopt knowledge management on project benefits should be mediated by barriers, or obstacles to knowledge management adoption.

H2: EPKM's effect on *project benefits* will be mediated by *obstacles* to knowledge management.

Knowledge management obstacles will then contribute to decisions about which knowledge management tools to use, on order to help the organization overcome those obstacles and realize the goal of higher project benefits.

H3: EPKM's effect on *project benefits* will be mediated by *obstacles* to knowledge management and then *tool use,* in a serial fashion.

Lastly, even if obstacles are not considered in the adoption and implementation of knowledge management practice (as might be the case with social mimetic pressures), tool use will mediate the relationship between the institutional pressure to adopt knowledge management and increased project benefits.

H4: EPKM's effect on *project benefits* should be mediated by effective *tool use.*

These combined relationships suggest the use of a mediation model that will help predict the relationships between the institutional pressure to adopt knowledge management (*EPKM*), perceptions of knowledge management *obstacles* and *tool* use, and finally the organizational outcome of *project benefits*.

Methods

Measures

To develop a broad understanding of the knowledge management (KM) being used in today's construction industry and its relationship to organizational outcomes, a

survey was developed and modeled after Forcada, Fuertes, Gangolells, Casals, and Macarulla's (2013) investigation of a similar type in Spain (see Appendix B for the full survey questionnaire). Elements of this survey were utilized to inform the research questions and hypothesis above. A description of the independent and dependent variables follows.

Independent variables. The first section of the questionnaire provided a brief description of the purpose of the project. It was important to remind participants that the questions were not designed to capture any commercially sensitive data, and that all information would be kept confidential in the reporting of any results. Also included in this introduction were definitions for knowledge management, as well as knowledge management systems. Knowledge management was defined as "a conscious attempt to utilize skills and know-how as organizational resources in order to maintain or improve a firm's competitive advantage, and can consist of a variety of tools, practices, activities, procedures and systems." Knowledge management systems were defined as "any structured practices that are implemented throughout the organization in order to effectively and efficiently manage knowledge, technological or otherwise."

After the introductory section, the first section was concerned with RQ1 (*To what degree do domestic construction organizations value knowledge management?)*, and used adapted questions from the Forcada et al.'s (2013) study. These included the questions, "To what degree does your organization value knowledge management as a strategic asset?" and "Is there currently any kind of knowledge management system in place in your organization?" Additionally, this section also included questions about the

potential contributions knowledge management offers their organization to asses the perceived value the concept held, the business opportunities they may be missing out on as a result of not exploiting current knowledge to indicate how much they believe their financial situation could be tied to knowledge management. This section also included a question about the degree to which the knowledge of one or two employees may be beneficial to a higher number of employees to see if they understood the value of the social aspects involved with knowledge management. Asking these questions allowed for a variety of responses regarding the value that organizational leaders placed on knowledge management.

Section two of the questionnaire consisted of a scale to measure the *obstacles* the organization faced in regards to knowledge management, and was concerned with H2 (EPKM's effect on *project benefits* will be mediated by *obstacles* to knowledge management), H3 (EPKM's effect on *project benefits* will be mediated by *obstacles* to knowledge management and then *tool use,* in a serial fashion), and RQ2 (*What barriers impede the development of knowledge management in the organization?)*. This scale asked participants, "What are the obstacles to developing knowledge management systems, on a scale of 1-5," with 1 being an insignificant obstacle, and 5 being a significant obstacle. The scale listed several common obstacles like the change in organizational culture needed to use these systems, low involvement of employees, people's fear of sharing what they know, and time needed and high cost of implementing a KMS (Cronbach's $\alpha = .845$).

Section three of the questionnaire was concerned with H3 (EPKM's effect on *project benefits* will be mediated by *obstacles* to knowledge management and then *tool use,* in a serial fashion) and H4 (EPKM's effect on *project benefits* should be mediated by effective *tool use)*. *Tool use* was measured with a scale adapted from Forcada et al. (2013) and inquired about the effectiveness of a list of common knowledge management tools like communities of practice, small group meetings, training and education plans, etc. (Cronbachs $\alpha = .846$). These options were rated on a 5-point likert-type scale ranging from very ineffective to very effective. There was also an option to indicate that a tool was not used, thus allowing the question to determine the overall number of tools used, as well as the efficacy of those tools.

The last section of the questionnaire dealt with project outcomes and institutional pressures for adopting knowledge management and information technology tools. Mimetic institutional pressure was the last independent variable measured and consisted of a scale adapted from Zorn, Flanagin, and Shoham (2011). This scale was concerned with H1 (The institutional pressure of the expected practice to adopt knowledge management (*EPKM*) will increase project benefit outcomes), H2, H3, and H4. Three items from the Zorn investigation regarding the expected practice of information technology use scale were reworded to reflect the same assessment for *knowledge management expected practice (EPKM)* (Cronbach's $\alpha = .766$). For example, an item from the knowledge management expected practice scale was "Organizations such as ours rely heavily on knowledge management practices these days." The other two items were "Normally, organizations that do what we do, *do not* use knowledge management

practices," (reverse coded), and "Typically, organizations in our field rely heavily on knowledge management practices." This scale was also measured using a 5-point likert-type scale ranging from strongly disagree to strongly agree.

Dependent variable. The last scale assessed organizational outcomes, and was the dependent variable for the study in all four hypotheses. *Project benefits* were assessed using a two item measure and included the items "The project's overall benefits exceeded owner's expectations" and "The project produced excellent results," (Cronbach's $\alpha = .783$). This scale is a modified version of the project benefits subscale found in Yang, Chen & Wang's (2012) study, and addressed the degree to which firms feel they were recently able to not only exceed the project owner's expectations, but also exceed their own market expectations by achieving "excellent" results that excel beyond those of their competitors, indicating the use of inimitable and non-substitutable knowledge resources.

Data Collection

Participants. The questionnaire was distributed to organizational leaders at the top construction organizations in the country including consulting engineering organizations and construction contractors. A mailing list was acquired from the publisher of the ENR Top 400 Contractors ranking in the in United States for 2014. The list is released annually in June, and the group recognized as the top contactors by revenue in 2013-2014 were ranked in the list used for this study. This edition of the ranking happened to be the 50th anniversary of ENR's popular and competitive list.

Accompanying the list were highlights of some of the major changes to the industry over the last 50 years; who was still on top, who had gone by the wayside, as well as some important trends and directions the industry was headed in. The report described the return of the construction markets to near pre-recession levels, as combined domestic contracting revenue for the Top 400 reached $249.34 billion, up 6.6% from the previous year, but still short of the 2008 record high of $281.36 billion. The overall lesson highlighted by the publication regarding the nature of the industry was that the recession taught contractors was to work lean, and the key moving forward was to carry on those lessons learned and work smarter (Tulacz, 2014). The report also highlighted the continued adoption of Building Information Modeling, also known as BIM, as a technological tool that started with 3D modeling and has continued to grow into more dimensions, as new databases are incorporated into the tool, turning it into a powerful pre-construction estimator and planning instrument. This technology adoption is yet another supplemental tool for knowledge management, as organizations realize the value in utilizing various data sources and compiling them in a way that allows project managers and organizational leaders to make better informed decisions and plans.

Survey. The mailed surveys included a personalized letter on university letterhead explaining the nature of the research and asking the organizational leaders to consider participating. Also included in the mailing was the information sheet explaining potential risks and what they should expect. The information sheet included links to digital copies of the document as well as a link to the online survey if participants preferred to complete the questionnaire electronically. A paper copy of the questionnaire

was included for them to complete along with a self addressed stamped envelope. The information sheet also served as a paper copy of the consent form, where participants could sign their name indicating their agreement to participate and whether they would like to be contacted for a follow-up interview or be sent a copy of the research findings. These options were also included in the online version of the questionnaire as well. This initial round of 300 surveys were mailed to organizational leaders across the country. 35 surveys were returned via mail and of those, two were invalid due to the recipient no longer being a member of the organization, and 28 were completed. Thus, the mail portion of the survey returned a 9.4% response rate.

Through a contact in the construction industry, the online survey link was posted to a forum for young professional organizational leaders in the industry. The total circulation of the online forum is unknown; however, prior to the link being distributed, there were no responses collected via the electronic version of the survey, which was being hosted on a university associated Qualtrics website. An additional 25 surveys were completed online, resulting in a total of 53 participating organizations representing a diverse cross-section of the domestic construction industry.

Data Analysis

The two data sets were first combined into an Excel document before being imported into SPSS for analysis. Once in SPSS, descriptive statistics and a correlation matrix were run on all variables, along with Cronbach's reliability tests for the scales being used. Descriptive statistics were used to answer the three research question regarding how much organizations currently value knowledge management, the

perceived obstacles to implementing knowledge management practice, and common tools used for knowledge management purposes. To test the hypotheses, a mediation model was needed to determine total, direct and indirect effects of expected knowledge management practice, perceptions of obstacles, and tool use on the project benefits outcome. Hayes (2009) argued for the use of bootstrapping techniques in the testing of intervening variable effects models, and as such, his conditional process analysis (Hayes, 2013), regression based approach to mediation was used to asses the relationships between the variables.

The model being tested was a mediation model with 2 mediation variables acting in parallel and serial fashion to test the total, direct, and indirect effects of the hypothesized relationships. The model (based on Hayes' 2013, model 6) included the independent variable of *expected practice of knowledge management* (EPKM), the dependent variable of *project benefits*, and two serial mediating variables of *obstacles* and *tool use*. In the model, shown in Figure 1 below, the direct effect of of *EPKM* on *project benefits* is denoted as c', the effect of *EPKM* on the first serial mediator *obstacles,* is a_1, the effect of *EPKM* on the second serial mediator, *tool use,* is a_2, and the effect of *obstacles* on *tool use* is denoted as d_{21}. For the effect of *obstacles* on *project benefits*, the denotation of b_1 is used, and the effect of *tool use* on *project benefits* is denoted as b_2. As a result, several relationships can be identified that will be tested. The total effect (c) is defined as the combination of all possible effect paths, $c = c' + a_1b_1 + a_2b_2 + a_1d_{21}b_2$. Along with the total effect, the direct effect of *EPKM* on project benefits will be tested to see if it is significantly different from zero (H1). Two indirect effect

paths demonstrate the indirect effects of *EPKM* on *project benefits*, through *obstacles* (H2), and *obstacles* followed by *tool use* (H3), while a third indirect effect path indicates only the effect of *EPKM* on *project benefits* as mediated by *tool use* (H4).

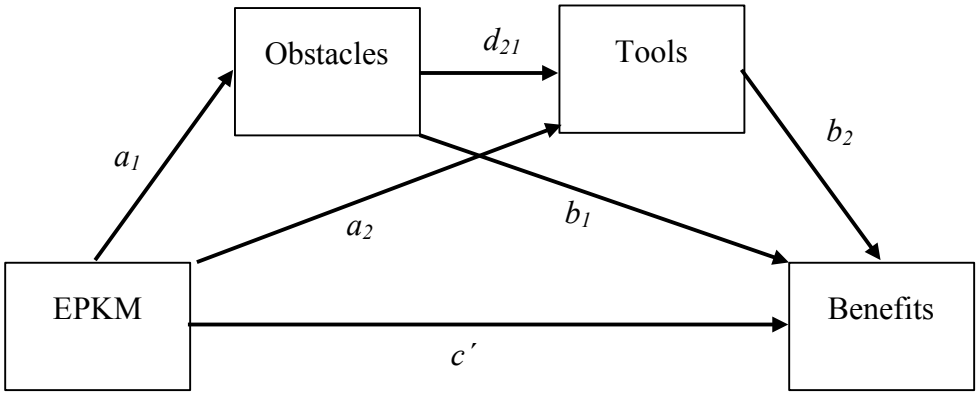

Figure 1. The Effect of Expected Knowledge Management Practice Among Competitors on Project Benefits is Mediated by Obstacles to Knowledge Management Implementation and Tool Use Among Construction Companies.

Results

Respondents

A total of 51 responses were collected from the survey with about half from the mail survey and half from the online posting. The organizational size ranged from 16 to 2500, with a mean of 545 employees. Respondents had been in their current position on average for 12 years, but ranged from 1 year to 48 years. Their average tenure in the organization was about 22 years.

The Status of Knowledge Management Practice in the Domestic Industry

The first research question asked about the degree to which construction organizations valued knowledge management. Several items were included in the questionnaire to establish the degree to which organizations valued knowledge management as well as document the amount of resources and effort they had placed into established knowledge management systems or activities. The respondents indicated that they found knowledge to be quite valuable as a strategic asset (on average, 4.31 on a 5-point scale, with 1 being not at all valuable and 5 being very valuable).

Another question attempted to indirectly ascertain how organizations valued knowledge by asking about the prevalence of costly errors or mistakes as a result of insufficient knowledge. Most respondents (82%) indicated that they were personally aware of situations where costly errors or mistakes were made due to insufficient knowledge. To follow up with that question, seven reasons for insufficient knowledge were listed, and respondents were asked to indicate which of those had led to errors. The most common of these reasons was the lack of sufficient knowledge about a process. More than half of the respondents (51%) indicated that this particular type of insufficient knowledge had cost the organization in one way or another. This indicates that a lack of *know-how* is most commonly the source of costly errors or mistakes among the sample.

Other common knowledge related causes included the repetition of previous errors (33%) and insufficient knowledge about he customers (33%). The repetition of previous errors could involve the same individuals, or a new group of individuals attempting to address a similar task or problem. Either learning didn't take place after

the first mistake, or those who learned from the previous error were not able to pass the new knowledge along to those who needed it. Knowledge about one's customers would be vital to understanding how to make crucial decisions when faced with difficult problems, as the customer is the one who is ultimately using the building. This highlights the importance of considering all stakeholders in the planning and building process during knowledge accomplishing episodes, as Chapter III has pointed out.

About 27% of respondents indicated that not having knowledge available when it was needed contributed to these mistakes, while 23% said that employees couldn't use or interpret information that was available to them. It's important to recognize that even when information is stored or available to employees who may need it, information alone may prove to be of limited use without the appropriate understanding of context and relevance. It is not enough to simply provide access to organizational repositories or experts (although that is better than not having the information or knowledge available at all), but organizational members must also be able to make sense of what is available in the given situation. This finding supports the assertion that knowledge is subjective and largely relational in nature, as the mere presence of information is not enough to prevent mistakes or errors from happening.

Relatively few respondents indicated that the loss of vital knowledge (16%) and insufficient knowledge about competitors (12%) lead to costly errors or mistakes for the organization. Organizations may be better at retaining the *most* important knowledge as employees come and go, or transition from one project to the next. Once a bid has been secured, little knowledge regarding the nature of one's competitors would be valuable

during the planning and building phases of the construction process, and as such, fewer errors are likely attributable to a lack of competitor knowledge.

Lastly, respondents were provided an additional space to indicate their own reason for knowledge related errors or mistakes. Only three respondents indicated other factors including "process not followed," "just something that we have never seen before" and "not using best practices." These responses, however, appear to be closely related to pre-determined available options. Not following established processes or best practices is either a result of insufficient knowledge about those processes or best practices, or repeating previous errors due to a lack of follow-through and learning. If organizational members were not following processes or best practice, even when they are aware of those processes or practices, then the error or mistake is less about a lack of sufficient knowledge, and more about *choosing* not to follow established guidelines, processes or best practices.

In terms of the potential contributions that respondents believed knowledge management could offer their organization, the mean for each of the ten contributions listed, on a scale of 1 to 5 (with 1 being "Not a at all Beneficial," and 5 being "Very Beneficial"), ranged for 3.9 to 4.65. This means that, on average, none of the potential contributions were considered to be less than beneficial. The most beneficial contributions established by the respondents included efficiency improvement and decision making improvement, followed closely by quality improvement and customers' and suppliers' relational improvement. The lowest rated benefit, labeled flexibility improvement, still achieved an average score of 3.9. These results add further support to

the significant value that is placed on knowledge management and its potential benefits to the organization. Next, the results regarding the degree to which domestic organizations have taken action to implement knowledge management practices into their organization will be reported.

Among the respondents, only 32.7% of the organizations had a knowledge management system (KMS) in place at time of response, while an additional 46.9% were either working on one or considering the possibility (13.7% and 29.4% respectively). Only 45.9% of organizations who responded had actually taken action on the development or implementation of a coherent knowledge management practice within their organization. This indicates that about 80% of the organizations were somewhere along the spectrum of implementing a KMS in their organization. The remaining 20% had no knowledge management system in place, and were not considering or planning to have one. These results indicate that, similar to previous research (Carrillo & Chinowski, 2006; Forcada, Fuertes, Gangolells, Casals, and Macarulla, 2013), many firms recognize the importance of adopting knowledge management practice, but relatively few have taken active steps towards adoption. There is a disconnect between the value placed on knowledge management practice, and the follow-through of creating, implementing, and supporting ongoing KMSs.

To further support the existence of this disconnect, only 12, or less than a quarter, of the organizations had specific KM officers or positions who were responsible for creating, implementing, and overseeing KM activities within the company. Looking at the qualitative data from this question, organizational leaders had a chance to indicate if

there was an "other" that was responsible for knowledge management activities if the predetermined categories of top management, department managers, or specific knowledge management officer/position did not fit their organizational process or structure. The "other" category returned a variety of responses that ranged from "I know nothing about knowledge management systems" to "total employee base." The second research question helps to further illuminate current practice.

Research question 2, (*What tools are being utilized to implement knowledge management strategies?*) sought to better understand the material and resource based activities that construction organizations might have employed in the pursuit of better knowledge management. This question was addressed with the knowledge management tool use scale. As respondents indicated the degree to which each tool was effective for their knowledge management purposes, they inherently indicated that they were in fact using that tool, instead of selecting the "not used" column in the scale. From this data, it's possible to gather a count of the tools used from each organization to help understand which tools are most prevalent among the domestic industry. The count of knowledge management tools used by the organizations ranged from five tools to all 12 indicated in the questionnaire. The average number of tools used among organizations for KM purposes was 10.27. While all organizations appeared to have at least a few knowledge management tools in place, their overall effectiveness as rated by the respondents tells a little different story.

On a scale 1 to 5, with 1 being "Very Ineffective" and 5 being "Very Effective," the average effectiveness of knowledge management tools ranged from a low of 1.85 for

consultancy to a high of 3.42 for email, with an aggregated mean of just 2.6. The overall average for tool use fell somewhere between "Somewhat Effective," and "Effective." Organizations ranked email, a relatively low social bandwidth communication channel, as the *most effective* knowledge management tool for their organizations (albeit with a relatively average score of effectiveness). Given the findings of Chapter III, which highlighted the social nature of knowledge management and the supporting role of technology in that process, that fact that email was considered the most effective of the available tools for organizations suggests that there is a need to find more effective methods for implementing knowledge management practices. The second most highly rated tool for organizations was the use of small group meetings between two and four people, with an average score of 3.15 on the 5-point scale. This was followed by training and education plans and databases, with means of 3.1 and 3 respectively. Quickly dropping off on the effective side of the scale were internet (2.88), talent acquisition (2.63), intranet (2.46), monitoring of projects/services by clients (2.27), video conferences (2.17), communities of practice (2.15), and decision making tools (2.15). Perhaps tool effectiveness was tied to the ease with which they could be implemented, as perceptions of obstacles to implementing KMS's were significant among the respondents.

Research question three (*What barriers impede the development of knowledge management in the organization?*) was concerned with the obstacles or barriers to KMS implementation. Among the respondents, material factors were identified as being the highest obstacle to overcome in developing a knowledge management system, as

respondents averaged a 3.51 on a 5-point scale with 1 being “Insignificant Obstacle” and 5 being “Significant Obstacle.” The material factors include the time needed and high cost associated with implementing a knowledge management system. Given the short-term time orientation of project based organizations, the time needed to consider the value and the specific nature of a KMS for the organization appears to be detrimental to it’s development or consideration. Beyond the conceptualization stage, implementing a new organizational system that requires changing of daily practices and organizational structures necessitates significant time commitments at all levels of the organization. Additionally, because time is a valuable asset to project based organizations, the time commitment to the development and implementation of a new KMS would involve at least a moderate financial investment. Beyond that, KMS’s may involve technological enhancements to improve information communication technologies and other technological tools that would help to promote and sustain KM activity.

At Constructors, for example, a daily planning book for field and project leads was initiated a little over a year prior to data collection and was still under revisions. The organization had experienced different reactions to the new daily planning practice, and found that the book and its questions were being used differently depending on the nature of the individuals using it and the operations tiers’ oversight of it. The book had been in development for several months by an individual who was spearheading the new project, long before it saw field use. The organization had spent time and money on the development process, rolled it out company-wide, and then had spent nearly a year adjusting the book to better suit their needs. While the process was likely saving them

time and money in problems and wasted resources, it certainly required a significant up-front investment in order to get the project functioning at a level where it would pay off for them in the long term.

Other significant obstacles included the change of mentality needed to use the systems, which had an average of 3.29 on the 5-point scale, the lack of proved methods of implementing a system (3.31), a lack of training among organizational members in knowledge management (3.19), and the change in organizational culture needed to use KMS's (3.10). Carrillo, Robinson, Al-Ghassani, & Anumba (2004) and Forcada, Fuertes, Gangolells, Casals, and Macarulla (2013) talked about culture in terms of business units' ability communicate across typical organizational and institutional silos. A knowledge sharing culture would promote the interaction and communication of dispersed groups, unique departments, and identifiable experts throughout the project lifecycle. This type of culture would also be highly reliant upon a knowledge focused mentality that permeated organizational members and project stakeholders. Changing such a mentality and instituting such a culture can be difficult in this sector, which is why others have suggested adopting knowledge management practices that fit the existing organizational culture, as opposed to trying to change it outright (McDermitt & O'Dell, 2001).

Some of the more insignificant obstacles as identified by the respondents included people's fear of sharing what they know with others, which had an average response of 2.26 on the 5-point scale. This lack of fear was accompanied by turnover (1.77) and layout of work spaces (1.74) as being the most insignificant obstacles faced

by organizations in their consideration of, or attempt to implement, a KMS. In addition to these descriptive results, this study also tested several hypothesis regarding the relationship between the pressure to adopt knowledge management practice and perceived project benefits.

The Effect of Mimetic Institutional Pressures on Knowledge Management Adoption and Outcomes

A serial multiple mediation analysis was conducted using ordinary least squares path analysis to test the hypotheses. All bias-corrected bootstrap confidence intervals for indirect effects reported here used 10,000 samples, and coefficients are reported in their non-standardized form in Table 2 (Hayes, 2013). H1 stated, "The institutional pressure of the expected practice to adopt knowledge management (*EPKM*) will increase project benefit outcomes." The mimetic pressure to adopt knowledge management practice in combination with obstacles and tool use was found to significantly and positively effect project benefits. The total effect of H1 was supported (c = 1906, $p = .047$). However, when isolating the direct effect of EPKM on project benefits, the effect was fully mediated by obstacles to knowledge management and effective knowledge management tool use. The social pressure to adopt the expected practice of knowledge management did not, then, produce a direct influence on project benefits ($c' = 1.04$, $p = .347$). This means that the existence of pressure to adopt innovative practice does not, on its own, lead to higher levels of project benefits, and as such, H1 was only partially supported.

The second hypothesis stated, "EPKM's effect on project benefits will be mediated by obstacles to knowledge management." The prevalence of obstacles without

the influence of knowledge management tools was also not found to affect project benefits (a1b1) as a mediator alone (the confidence interval for a1b1 included zero, -.155 to .057).

Table 2. *Hypothesized Relationships Between EPKM, Obstacles, Tools and Project Benefits*

Effect	Coefficient	Lower Level CI	Upper Level CI	p-value
Total Effect (*c*)	.1906	.003	.378	.047
Direct Effect (*c´*)	.1039	-.117	.325	.347
H2 (a_1b_1)	-.031	-.155	.057	
H3 ($a_1d_{21}b_2$)	.035	.005	.112	
H4 (a_2b_2)	.083	.006	.254	

As such, the influence of tool use was an essential mediator in creating beneficial outcomes for construction organizations. Obstacles, similar to institutional mimetic pressures, effected tool use, but not project benefits.

The fully mediated indirect effect of EPKM on project benefits, mediated first by the perception of obstacles of knowledge management and then secondly by knowledge management tools, was shown to positively effect the project benefits experienced by the organizations. This indicates that hypothesis three, "EPKM's effect on *project benefits* will be mediated by *obstacles* to knowledge management and then *tool use,* in a serial fashion," was supported ($a_1d_{21}b_2$ = .035) as the confidence interval range did not include 0 (.005 to .112). This means that as construction companies noticed their competitors

adopting knowledge management practices, they were able to realized more project benefits by first perceiving the barriers of implementing those practices, and then implementing more effective tools of their own.

And finally, when not considering the effect of knowledge management obstacles at all, the indirect effect of EPKM on project benefits, mediated by knowledge management tools was also significant (a_2b_2 = .083). Hypothesis four found support (H4: EPKM's effect on *project benefits* should be mediated by effective *tool use*). These results indicate that tool use is the lynchpin in recognizing benefits associated with the pressured adoption of innovative knowledge management practice.

Discussion

This study demonstrates the value of knowledge management practice in achieving important organizational outcomes like project benefits. These benefits arise from the mimetic pressures to adopt certain organizational practices that spread through the industry. In order to maintain or improve competitive advantage in a difficult industry like construction, a variety of KM oriented tools should be brought to overcome the challenges associated with implementing new KM practice and achieve higher project outcomes. This study provides further evidence of the link between the pressure to adopt new KM practice, the mediating factors involved with the adoption of that new practice, and the indirect effects that leads to increases in quantifiable organizational outcomes.

The serial mediation model was able to demonstrate that institutional mimetic pressures resulted in, at least indirectly, a higher level of organizational benefits. It

makes sense that the direct effect was not found to be significant, given that pressures alone would not be enough to influence organizational outcomes without some type of intervention. That intervention, partially as predicted, included how organizations perceive barriers to KMS implementation followed by the effectiveness of tools used for KM purposes to help achieve better project results and exceed customer expectations. The deciding factor, then, was a firm's ability to institute effective KM tools that fit their particular KM needs. It's unclear, however, from this data, how organizations determined their KM needs and were able to make changes to their culture and daily practice to institute KM practices that they felt would be effective. While this study wasn't able to necessarily capture the situated *how,* it was able to provide insight into the status of KM practice in the domestic industry. The data gathered at Constructor's, however, can be used to shed some light on *how* one company was using a knowledge management system.

For Constructors, the need to establish anticipatory practices that took advantage of the local and dispersed knowledge of their organizational members and larger contractor network lead to the development and implementation of structured occasions. Their knowledge management tools were focused on the planning and organizing steps prior to and during the project in order to ensure that the best field, project and operations tier talent was being utilized, given the unique challenges that were anticipated. Such a practice, while not without it's limitations, also required a learning-in-organizing culture. The unique culture at Constructors was key in promoting and sustaining the effectiveness of the knowledge management system. The culture

promoted the use of questioning and a pseudo transactive memory system that allowed project stakeholders to 1) recognize who held the appropriate expertise needed to design a project plan and implement it; 2) legitimate actions and suppositions at multiple levels of the organization during planning and implantation; 3) hold internal and external stakeholders accountable for roles and actions by having a clear and well organized division of responsibilities and timelines; and 4) negotiate the embodied knowledge of experienced craft to balance the conceptual work of other stakeholders. It appears that Constructors was among a relative few domestic construction companies who had taken the opportunity to reimagine their culture and processes. The discussion of the results follow next, followed by a conclusion with theoretical and practical implications and limitations with suggestions for future research.

Not only was this study able to further support the validity of the communicative influence and benefit if KM practice in the construction industry, it was also able to document the degree to which the mimetic pressures among competitors have influenced the overall perception of KM. The fact that nearly 80% of the respondents were somewhere along the continuum of realizing a KMS is clear evidence that these practices and concepts are no longer on the fringe. KM appears to have already become a known factor, and most organizations are, at a minimum, aware of its benefits. It is encouraging to see that over half of the organizations who value KM as a strategic asset have changed their organizational practices in an attempt to realize the potential benefits that could be available to them. It's important to note here too, that just because most organizations recognized information technologies like email as an effective knowledge

management tool, doesn't mean that every organization who uses email (as that assuredly would include all companies in the industry) is using it in a strategic and meaning knowledge management capacity.

When identifying who was responsible for KM activity within the organization, the wide range of results indicates that there is a myriad of approaches taken towards KMS implementation. Given the social nature of knowledge, and the inevitable variability of expertise and knowledge domains around the organization, it makes sense that some see KM activity to be a responsibility of all organizational members. Others have recognized the importance of having a dedicated knowledge management "officer" who could lead the organizational culture change that is commonly acknowledged as a barrier to such activities (Carrillo, Robinson, Al-Ghassani, & Anumba, 2004). Further research may be needed to explore the merits of different types of KMS implementation. It's clear that many of the respondents have a concept of what knowledge management is, that it can be of value to their organization, and that they may need to engage the concept in some meaningful way, but it remains unclear as to what exactly is being done in each organization and to what degree it benefits the organization and its customers.

When comparing these descriptive results on the state of KM in the domestic industry to that of previous studies, a few conclusions can be reached. Much like Carrillo, Robinson, Al-Ghassani, and Anumba (2004) found in their U.K. survey, this study found that developing organizational culture and standardized work processes that value and promote knowledge sharing and communication were considered to be among the most significant barriers to KM implementation. The results of this study indicated

that about about three quarters of the construction companies surveyed in the United Kingdom in the study (n = 53) used, or were considering the use of, KM strategies in the short term. Carrillo and Chinowski (2006) found in their investigation of U.S. construction firms (n = 30) that most organizations had methodologies for capturing lessons learned from projects, but only about half of the respondents had taken action to incorporate standardized KM practices that were anticipator rather than reactionary.

When comparing this data with Forcada, Fuertes, Gangolells, Casals, and Macarulla's (2013) study of Spanish design and construction companies, similar results were found regarding the number of organizations who were somewhere on the spectrum of implementing or considering the implementation of a KMS. Their data found that about 30% of the construction organizations who responded actually had some kind of KMS in place. Comparing that to the 33% in this study, and in conjunction with the other data from previous studies, it appears that KM practice has remained relatively well known yet largely at the conceptual level as many organizations struggle to implement KMS into their workflow. Both Forcada et al. (2013) and this study found about a quarter of the organizations who responded had designated KM officers, and while Forcada et al. argued that mostly large organizations appoint specific knowledge managers, the organization size of those who responded in this study as having a specific knowledge manager position ranged from 40 employees to 2000. While larger organizations perhaps have more to gain from planned KM activity championed by a specific KM role, it could be just as valuable to smaller organizations who are working

diligently to maintain or increase their market share in an already crowded and competitive market.

It was promising that respondents recognized small group meetings and training and education plans as being among the most effective KM tools in this study, but disheartening to see the overall lack of effective KM tools. These findings again mirror Forcada et al.'s (2013) investigation where they reported the most effective tools to be small group meetings, email, intra and internet, and training and education plans. Small group meetings could constitute informal communities of practice (Carrillo & Chinowski, 2006), or, like what was seen at Constructors, support structured occasions that attempt to systematize the bidding, planning and building process conversations that are valuable for multiple levels of the organization.

Given the "sticky" nature of knowledge (Kazi, 2005; Quintas, 2005), particularly as individuals are met with more indeterminate, or unique problems where knowledge instruction and improvisation are needed (Kuhn & Jackson, 2008), creating opportunities for face-to-face problem solving and interaction among the wide range of project stakeholders is a valuable tool that could help overcome the lack of effective practices found in these results (Orlikowski, 2002). The mix of information communication technology (ICT) and non ICT tools being ranked as the most effective for knowledge management activity indicates that domestic organizations recognize the need to use a variety of tools to create effective KM practices. It's also not a surprise that organizations turn to tools which are already a part of their organizational structure, particularly regarding ICT's like email, databases and internet technologies that are used

for other purposes. Adapting tool use for other purposes on top of their original intention would clearly appeal to the short-term outcome and time orientation that construction organizations commonly work under (Bresnen, Goussevskaia, & Swan, 2004).

Conclusion

These findings suggest that organizations have found the pressure to adopt knowledge management approaches an important one. These adoptions appear to have stalled as the population of organizations that have embraced such practices, or are planning to in the short term, are similar to studies conducted domestically and abroad over the last decade. The industry's use of knowledge management tools appears to offer significant benefits in terms of project outcomes, but the relationship between institutional pressures to adopt and observable benefits is tempered by obstacles to KMS implementation and effective KM tool use. Taken together, these data suggest that construction organizations, big and small, can benefit from attending to the needs of the dispersed, short term, project oriented nature of construction work with the use of communicative knowledge management activities, and that this change would be a sound investment of organizational time and resources. Next, the theoretical and practical implications that can be derived from this study are identified.

Theoretical Implications

Theoretically, these findings lend additional validity to knowledge management concepts and their relationships to organizational outcomes. Previous studies had established knowledge management's fully mediating role between information technologies and organizational outcomes (Yang, Chen & Wang, 2012). This

investigation sought to provide further evidence of the direct, causal relationships between the pressure to adopt KM practice, the barriers to that adoption, KM tool use, and project benefits. By providing a link not only to project benefits from KM tool use, but also extending the relationship to include the motivational factors involved with adopting those KM activities, namely the competitive institutional pressures that drive organizations to emulate others who they deem as their direct peers and competitors in order to maintain or increase their competitive advantage (Rogers, 2010; Zorn, Flanagin, & Shoham, 2011), these findings have provided a more comprehensive picture of the organizational change lifecycle. The observation of theses theoretical relationships also points to several practical implications.

Practical Implications

Organizations who view these results should consider the fact that tool use is a necessary but not sufficient action for knowledge to be managed in the work setting. Email, for example, is ubiquitous, and it functions as a convenient way to communicate information across a variety of audiences. But many of these tools in and of themselves do not constitute knowledge management. Instead, ICT's like email, intranet and the use of databases to store large amounts of information regarding previous projects and organizational performance are important starting points towards engaging an organization in KM practice. Construction organizations should be considering how those tools fit into their KM goals, the ease with which they can be implemented (or adapted) for KM purposes, and how they can serve to support more rich communicative activities that are required for the inherently social nature of knowledge and knowing

(Bresnen, Edelman, Newell, Scarbrough, & Swan, 2005; Brown & Duguid, 2001). A database of previous work and "lessons learned" does no good if the organization doesn't have the capability to bring those lessons to bear at the right time and interpret them in an appropriate way in order to create capacities for action in a given knowledge accomplishing activity (Kuhn & Jackson, 2008).

Material limitations and constraints were the biggest obstacle to implementing KMS, so it will be important that organizations invest in the structures and positions that will help reduce those material barriers (time, money, geographic dispersion) if they want their KMS's to be long-lasting and fruitful. While only a few organizations had a designated position to oversee the strategic goals associated with KM, many more organizations may find it useful to invest in dedicated KM officers that can help to engender the value of KM practice and tool use among all levels of the organization (Storey, & Barnett, 2000). And now that this study has added to the tangible evidence available to organizational leaders that demonstrates the value associated with strategic KM activities, it will be easier to make a business case for these types of investments in personnel and supporting tools.

Limitations and Future Research

There are several shortcomings to this study that need to be recognized and coincidentally, opportunities for future research will be also be discussed. First, some may argue that structural equation modeling techniques that utilize maximum likelihood procedures in software like Mplus or LISREL would have been better tools to estimate the multiple mediation model described in this study (e.g. Iacobucci, Saldanha, & Deng,

2007). Benefits to using such approaches included more flexibility when estimating models in terms of control over what effects to include or hold to zero. Also, if latent variables had been needed in the model, a structural equation model (SEM) would have been necessary. With SEM, however, because so many parameters are often being estimated, larger sample sizes are needed to detect the mediation effects (Frazier, Tix, & Barron, 2004), and this study's small sample size would have likely prevented the model from achieving good fit with the data.

The PROCESS tool, on the other hand, can only estimate the types of models that it is programmed to. Hayes (2013) demonstrated, however, that maximum likelihood and ordinary least squares (OLS) regression coefficients will be nearly identical in multiple mediation models, and that path coefficients may even be better estimated in OLS regression with small samples like the one found in this study. This is a because the *p*-values in structural equation models are derived from the normal distribution instead of the *t*-distribution that's used for regression coefficients in OLS. This point of contention leads to another limitation of this work.

Secondly, there are limitations to the nature of survey research and the sample collected for the study herein. Such a low response rate and 51 cases to draw inferential conclusions from indicates that these results should be considered in light of the relatively small sample size. To engage 51 organizations out of likely several thousand economic contributors to the industry should be a consideration when generalizing these findings to the industry as a whole. Recently, Chidlowa, Ghaurib, Yeniyurtd, and Cavusgile (2015) reported that among a sample of 285 international business research

articles, the average response rate using Dillman's (2000) mail survey method was 37.5%. Only 20 studies, or about 7% were below a 10% response rate, which is where this study would have been categorized.

However, considering the similarities between these findings and those of previous studies of both domestic and international firms, it appears that this sample is relatively representative of the industry. Unlike Forcada, Fuertes, Gangolells, Casals, and Macarulla's (2013) study, these data included small to medium enterprises, and it provided further evidence that KM, it's related pressures, challenges, tool use and outcomes are pertinent to all construction organizations, regardless of size. It would be useful, however, to understand more about the important distinctions between small to medium enterprises and larger firms in their conceptualization of, or specific uses and unique benefits associated with, KM practice or KMSs. In addition to the small sample size, the survey technique is susceptible to response bias, as those who are interested in KM or already value KM as a strategic asset may be more likely to complete the questionnaire. In addition, due to the fact that organizational leaders were completing this questionnaire, it could be argued that they might inflate their own organization's performance on outcomes like project benefits. They may also not be the most intimate with the workings, successes and challenges associated with their last major project (which is the project they were asked to consider when responding to the outcomes portion of the questionnaire).

Project benefits that consist of exceeding owner's expectations and producing excellent results are valuable intangible outcomes. There is more work to be done,

however, in regards to establishing further empirical evidence that KMSs, or the implementation of a variety of KM tools, can effect an organization's bottom line (i.e. producing more fiscally beneficial projects) through achieving better timelines, product quality, and perhaps more importantly, safe project outcomes (i.e. fewer accidents and incidents on site) (e.g. Yang, Chen & Wang, 2012). Evidencing the communicative accomplishment of knowledge work by demonstrating its effect on more tangible organizational outcomes would further help establish validity for the KM construct and support the expenditure of additional organizational resources to ensure its successful implementation and continuation in the industry. Another benefit of KM practice is the increase in innovative capability that can result from it's use alongside certain relational practices (Fu, 2015, Peltokorpi, 2014). By extending Fu's findings into the construction industry, it could be possible to achieve a higher rate of innovative achievement, something the industry is criticized for lagging behind in when compared to other sectors like manufacturing (Dubois & Gadde, 2002; Styhre, 2009).

Similarly, it would be useful to find evidence of the most effective communicative knowledge management activities for the construction industry. What are the communicative knowledge management activities that function most effectively for dispersed organizations? We need further investigations of different forms of knowledge management practice which compares their ability to effect change in organizational outcomes. What are the processes involved with selecting the best KM approach for different construction companies given each organization's unique challenges and needs associated with managing their own networks of expertise?

Addressing these types of questions would help construction companies become more aware of their options in selecting and implementing certain KM tools and cultural shifts associated with the commitment to those types of activities.

CHAPTER V

CONCLUSION

Taken together, the findings of these two studies are evidence of the communicative accomplishment of knowledge work. The goal of this project was intended to develop a deeper understanding of (1) how organizational members communicate what they know with others to solve problems and create capacities for action in our everyday work practice; (2) the level of knowledge management use among domestic construction organizations; (3) what motivates organizations to adopt new knowledge management practices; (4) whether communicative knowledge management practice had measurable benefits to the organizations who were attempting to implement it. This research has been able to address each of those inquiries and provide further insight into the nature of knowledge management in the form of two interrelated, yet methodologically different studies. A brief summary of these findings are highlighted here before a more detailed review and incorporation of the findings as a whole are discussed.

Regarding the first inquiry listed above, Chapter III identified daily communicative practices like directing questions to others who are identified as knowledgeable and engaging all levels of the organization during the planning of a project. These practices were apparent in the intersections of a learning-in-organizing culture, relational communicative management activities, and elements of Kuhn and Jackson's (2008) framework for practice-based research on knowing. This investigation also revealed the need for a fourth situation framing resource, embodiment, to be

considered in Kuhn and Jackson's (2008) framework to better capture the body knowledge that plays an important role in negotiating the appropriateness of discursive moves within knowledge accomplishing episodes. The study also highlighted how organizational members utilized elements of a transactive memory system as they identified who knew what, but did little else to formalize or maintain unique knowledge domains outside of their safety practice.

The remaining research inquires were addressed in Chapter IV. Survey research was able to gather data regarding the general perceived value and usage of knowledge management in today's domestic construction industry. The results indicated that while a majority of organizational leaders perceived knowledge as a valuable organizational asset, only about a third of the organizations who responded actually had a knowledge management system of some kind in place, meaning that it is still a relatively uncommon practice industry-wide. Knowledge management adoption due to mimetic institutional pressures led to higher levels of project benefits. In addition, that relationship was also shown to be mediated by obstacles to knowledge management adoption and subsequent knowledge management tool use. The results indicate that organizations are influenced by the pressure to adopt new, innovate practices when they see others in their market adopting those practices. This ultimately leads to increases in project benefits which contribute to the firm's market competitiveness, but not before they face numerous obstacles to adoption and develop tools to cope with and overcome those issues.

Before highlighting some conclusions and implications based on the combination of the data and findings presented in the previous chapters, I'll review each study's

findings independently. This chapter will conclude with some suggestions for future research along with a few propositions that help to provide structure to the continuing questions that this research has surfaced.

The Communicative Accomplishment of Knowledge Work

Chapter III assumed a practice perspective to understand the communicative accomplishment of knowledge work in a dispersed construction organization. The study conceptualized knowledge as an ongoing experience that can be seen in the mangled practice of communication. Theoretically, the study relied on the work conducted by Styhre (2009) among several construction organizations over the course of a decade in Europe and Scandinavia. Styhre saw communication as the building blocks for the relationship dependent knowledge management practice that constituted organizational reality and activity. He also suggested the need to reexamine our knowledge management practice, "the traditional *'laisse-faire* model' for knowledge-sharing demands little time from the construction industry co-workers but it is also a fickle model whose ability to exploit underlying knowledge bases may be called into question" (Styhre, 2009, p. 168, emphasis in original).

Styhre's perspectives were mirrored in another theoretical contribution from Kuhn and Jackson (2008), who argued for a practice-based perspective of knowledge work that assumed knowledge was relational, action oriented (i.e. more about *knowing* and less about static *knowledge*, per se) and subjective. Kuhn and Jackson (2008) thus proposed a framework for practice-based research on knowing, which was employed in the study to provide a template from which to analyze the daily communicative practices

captured in the qualitative data. Lastly, Peltokorpi (2014) suggested that structures and relationships were necessary tools for systematic knowledge management at the organizational level. These propositions were attended to through the inquiry into the existence and use of transactive memory at the organizational level within and among Constructors business units. This helped shaped the first research question regarding the daily activities of organizational members: *What are the daily communicative activities that facilitate the coordination of knowledge and expertise in a project based organizational structure?* A second, closely related research question (*How is relational knowledge management practice related to cultural organizational learning in the project based construction organization?*) was also proposed to help disentangle the nature of relational communicative practice and a learning-in-organizing culture that can be useful in supporting systematic knowledge practice (Cook & Yanow, 2011; Gherardi & Nicolini, 2002).

The analysis of the communicative accomplishment of knowledge work among organizational members at three Constructors sites utilized a matrix of Kuhn and Jackson's (2008) three situation framing resources (identification, legitimacy of action, and accountability) in conjunction with the learning-in-organizing culture and relational communication knowledge management activities concepts as an analytical tool. A result of Constructor's shared value for learning and empowering was indeed a learning-in-organizing culture that valued systematic approaches to knowledge management through the use of structured occasions which guided projects through production phases. These organizational structures, as Peltokorpi (2014) suggested, did allow for

systematic identification of relevant actors when someone was presented with a problematic situation. They also lent legitimacy to organizational member's actions, and provided a clear sense of accountability that promoted a team-oriented work process where each project member learned from the other to create capacities for action relatively quickly and accurately, thus supporting a pseudo transactive memory system.

The study documented both systemic organizational practice and informal organizational culture (both of which lend legitimacy and accountability to one another) that promoted and engaged the communicative accomplishments of knowledge work through activities and practices. These included things like the use of mentors to coach new organizational members on the standard operating procedures and how to deal with the challenges of learning a new position. Project leaders or coordinators were occasionally matched up to compliment one another on complex projects where their relational communication and unique knowledge domains could be best utilized. Those in the field were tasked with proposing their own plans for implementing new projects, which promoted a learning-in-organizing approach and relied on relational communicative knowledge management activities of incorporating outside knowledge resources and stakeholders.

Structured occasions quickly fell short, however, towards the completion of the project, where the organizational members then relied on more informal and spontaneous opportunities to share what they knew with one another when and if the time arrived for it. A lack of after-action reviews or systematic debriefing and institutional learning following a project demonstrated the largely oral culture that the

construction industry relies on, as formal written or digital documentation are deemed as less useful and too time consuming (Styhre, 2009) for most to employ consistently and effectively. Thus, a pseudo transactive memory system was in place as individuals relied on the identification of those who held certain knowledge domains to provide them with specific kinds of knowledge when they needed it, but outside of those activities, much of the knowledge coordination, particularly outside of the structured occasions, relied on an informal story-telling practice.

The results highlight that knowledge is indeed a socially constructed, action oriented, subjective (Kuhn & Jackson, 2008) phenomenon that plays a role in work life, even if it isn't always consciously attend to. In fact, the act of knowing in the construction context indicated the need for a fourth situation framing resource that should be added to Kuhn and Jackson's (2008) framework. I described this fourth situation framing resource as embodiment, or embodied resources that knowledge workers in construction rely on to establish the visceral learning and knowing associated with the body work that is involved with many construction processes and dilemmas. Drawing on this aesthetic knowledge resource helps organizational members determine the level of appropriateness of discursive moves.

The State of Knowledge Management and Its Effects on Project Outcomes

Chapter IV of this dissertation was concerned with several research questions regarding the nature of knowledge management as it is used today in the domestic construction industry. Hypotheses proposed relationships between the institutional pressures to adopt KM practices and related outcomes. First, the research questions

asked about the degree to which current construction organizations valued KM strategies, the tools that were being utilized in for KM practices, and lastly, about the barriers or obstacles to the implementation of KM strategies.

The findings from the survey data indicated that nearly all of the organizational leaders who responded (n = 51) believed that knowledge held strategic value to their organization and its goals. Another question identified that about 80% of the organizations were somewhere along the continuum of developing, implementing, or sustaining some form of knowledge management system, again indicating that most organizations believed these practices were important. However, only around a third of the organizations had knowledge management systems in place at the time of their response, indicating that there are significant barriers to the implementation of such practices.

The barriers and related knowledge management tool use results indicated that material factors like time and financial considerations were the most difficult obstacles to overcome when attempting to implement KM tools within the organizations. It's difficult to find the time needed to incorporate new strategies, or carve out budget allocations for long-term KM activities when other leaders and organizational members may not see the relevance or potential for return on investment. This ties into some of the other barriers that were highlighted in the results, including how difficult it is to achieve the necessary change in mentality among organizational members during the implementation of new KM systems. On top of that, practitioners felt that there is a lack of well established methods for carrying out KM in project based organizations. Several

researchers have highlighted best practices (e.g. Al-Ghassani, Anumba, Carrillo, & Robinson, 2005), but it also costs time and money to train organizational members on those practices (not to mention the cost involved with determining the appropriate types and amounts of KM tools to utilize). So there are significant factors to be considered when embarking on a KM change initiative within the firm, but despite that, many organizations were able to estimate the effectiveness of certain tools that they did have the capability to utilize.

Effective tools included a mix a both social and technological options. Among the most effective tools highlighted by the survey respondents were email and databases on the information communication technology side. On the social side, small group meetings and training and education plans were among the highest rated tools. The average number of tools used by the collection of organizations who responded was about 10, which indicates that while many organizations didn't have complete, or universal knowledge management systems in place, they were using various tools to help promote the communication and spread of know-how.

Four hypotheses were tested in a serial multiple mediation model to determine the direct, indirect, and total effects of the mimetic institutional pressure to adopt knowledge management practice on project benefits, along with the mediating effects of obstacles and knowledge management tools. The results of the analysis indicated that there was indeed a total significant effect. The institutional pressures to adopt knowledge management, along with obstacles to knowledge management, and effective knowledge management tool use, had a significant positive effect on observable project outcomes.

These outcomes included perceptions about exceeding the owner's expectations and producing excellent project results.

Institutional pressures indirectly effected project benefits when considering both mediating variables in serial (obstacles followed by effective tool use), or when only considering effective tool use as a mediator between the expected practice to adopt knowledge management and project benefit outcomes. In other words, organizations see their competition adopting knowledge management tools and systems, and attempt to do that same thing. The success of that adoption, at least in terms of project benefits, depends on the organization's perceptions of the obstacles involved with that adoption, and the effectiveness of the tools that they eventually adopt. These findings are among the first to establish significant, empirical evidence that institutional pressures influence knowledge management adoption and ultimately organizational outcomes like project benefits.

Many in the knowledge management literature have argued for the value of KM practice, and the potential for its influence on an organization's bottom line. Few, however, have recognized *why* organizations eventually do adopt such practices, particularly in light of the scant direct evidence of knowledge management's relationship with other project outcomes regarding budget, product quality, job-site safety, and schedule performance (Yang, Chen, and Wang, 2012).

Considering the survey research in light of previous studies, this data indicates that the state of knowledge management as it stands today in the domestic construction industry is widespread. Quintas (2005) suggested that organizations in a Western culture

may be at a disadvantage given their propensity for short-term outcomes and proclivity for codified knowledge or information instead of fostering the rich, socially constituted and contextually relevant capacities for action associated with transactive knowing. Communicative knowledge management practice shows promise in becoming a significant organizational factor for leaders to not just consider, but invest substantial resources into.

All considered, the findings conclude that practitioners and academics should work even harder toward the development and implementation of knowledge management systems that utilize underlying norms, expectations, structures and organizational goals to align all levels of the workforce in a common endeavor to more effectively embody communicative knowledge work in order to achieve competitive and innovative advantage. Suggesting this involves several theoretical and practical implications which rely on the mutual consideration of both research projects. These conclusions will be highlighted next, followed by several suggestions for future research.

Theoretical Implications

Kuhn and Jackson's (2008) framework for investigating knowledge is useful in understanding the negotiated framing resources during problem solving episodes. It becomes more accurate, however, when considered with the additional embodied situation framing resource described in Chapter III. In doing so, their framework is extended to include considerations for the skilled/non-skilled dimensions associated with much of the knowledge intensive work that is relied upon in the construction industry. Capacity for action, when considering the embodied expertise inherent in craft work

(e.g. Sennett, 2008), can quite literally come from one's ability to manifest knowledge in the form of physical movement, or in the form of a discursive move which is itself informed by aesthetic knowledge. The negotiation of these situation framing resources is highly dependent upon the culture of the organization, which is likely shaped by institutional pressures to adopt people-centered, or resource based views of the firm where people are the main focus of organizational changes to promote relational communicative knowledge management activities and organizational learning.

Transactive memory systems could be functional on the organizational level (Jackson & Klobas, 2008); however, their function needs to be adjusted to account for the natural overlap of knowledge domains among business units or project teams within the same organization. Transactive memory systems require significant levels of interpersonal interaction to build trust and mutual understanding of task-expertise-person units that can then be used to retrieve the appropriate information or expertise given a particular problem. It's clear that implementing a knowledge management system like a functional TMS is challenging for firms, as most are still considering how to best approach it. For something like a TMS to work at the organizational level within the construction industry, it would require first the cultural and structural support that would be necessary to engage expertise from such dispersed knowledge sources. It would no longer be enough to have a mutual understanding of an interdependent goal to drive the formation, updating, and utilization of the organizational system. A particular culture shift would be necessary, and should be considered among the fundamental factors in organizational transactive memory development and sustainment. Given the relatively

small number of firms who have adopted KM systems, TMSs might be a useful starting point for organizations to help overcome some of the challenges associated with KM adoption.

The nature of knowing as it relates to our communicative practice has evolved and changed over the last few decades. Because of this, how we conceptualize and commonly refer to knowledge management is shifting. Knowing is a social process (Sthyre, 2009), seen in knowledge accomplishing episodes resulting in a capacity for action that is local and context specific (Canary & McPhee, 2010; Davenport & Prusak, 1998; Quintas, 2005). The social action of knowing is then shaped in part by organizational structures (Kale & Karaman, 2012) which are shaped by, and interact with, wider institutional pressures.

Organizational structures also interact with the organizational cultures that influence day-to-day interactions (Zheng, Yang, & McLean, 2010), and it is among these day-to-day communicative activities where the accomplishment of knowledge work is realized (Kuhn & Jackson, 2008). Organizational culture has been shown to be the largest contributing factor towards effective knowledge management, outweighing organizational structure and strategies (e.g. proactiveness, analysis, defensiveness, and futurity) (Zheng, Yang, McLean, 2010), and as a result, it is necessary that stakeholders in the construction industry think of knowledge management as not just a stand alone activity. While firms are always engaged in different levels of knowledge accomplishing activates through their communication and action, such activity alone does not constitute knowledge management. Instead, this investigation calls to attention an imperative

cultural and ideological shift. One that is needed to move the industry away from a traditionally reactive machismo institution. An institution that perhaps still over-values the heroic, yet uninformed, pull yourself up by your bootstraps, get it done at any cost, sink or swim hardliner approach that, quite frankly, is unsustainable and lacking the sophistication needed to keep pace with today's building demands. An institutional level reconceptualization and understanding of knowledge management as something that exists outside of databases and in the communication of know-how in all of its forms will require several practical steps that could help to transform current struggles and inefficiencies among construction firms. One way to begin such reformulations is to consider the theoretical connections among the multitude of concepts and ideas that have been addressed in this research project.

The two research endeavors presented here represent a micro and macro look into the conceptualization and consideration of knowledge accomplishing communicative work among construction workers. Chapter III was micro in it's investigation of the individual and group daily practices among a single construction organization. This was done in an attempt to better document and understand the knowing in action that constitutes the knowledge resources that could be brought to bear at any given time. These knowledge resources are not static, however, and are shaped by macro forces. Chapter IV attempted to better understand industry trends and activities on a broader scale by surveying construction organizational leaders. Through the process of collecting the sample and aggregating responses, a macro view of the industry was portrayed. In addition, the quantitative data also gained perspective on the hidden macro

institutional drivers which acted to influence the adoption of knowledge management practices and ultimately, project benefits across the industry. These relationships, and opportunities to discuss the intersection of interdependent, mutually constitutive micro and macro observations will be drawn from the model of the communicative accomplishment of knowledge work shown in Figure 2.

Starting at the top of the model, the macro factors involved with knowledge work in the construction industry are identified along with their relationships as described by Chapter IV. Industry challenges are noted at the top of this model as well to indicate the inherent nature of project-based, dispersed organizational work like that found in the construction industry. These challenges play an important role in the formulation of the issues being addressed by the research studies in this project. While many industries or sectors of the economy face dispersion and time pressures as a part of their work experience (e.g. global software developers or international project management), very few industries face the same combination of factors working against the coordinated effort and communicative capabilities needed to construct the complex projects the construction industry is responsible for. These challenges include the novelty of each building or structure, the geographic dispersion of project members and organizational units, the conflict of expertise between the theoretical or conceptual and the embodied, the time pressures that projects are placed under, and the fragmentation of the industry regarding the number of unique firms that are required to work interdependently with one another on each project.

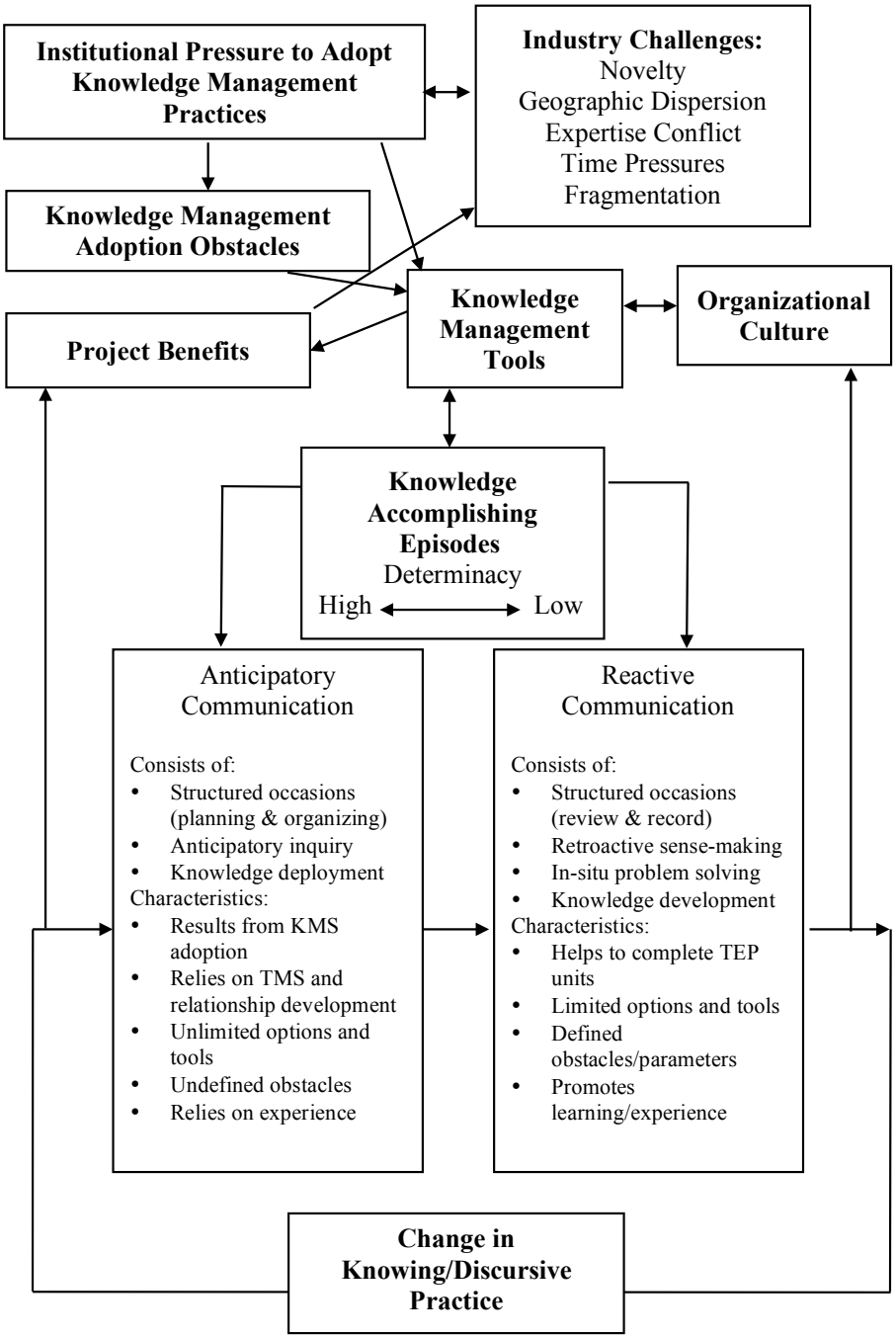

Figure 2. The Communicative Accomplishment of Knowledge Work Model.

The industry challenges are intertwined with the macro institutional pressure to adopt knowledge management practices. These two forces work on one another over time, as the challenges associated with the construction industry feed into the collective mimetic pressure to adopt new approaches to managing expertise and know-how. This has been evident particularly among larger firms who experience these challenges to a higher degree than small to medium sized enterprises, as they have the resources to dedicate to addressing some of these large-scale challenges within the system (Forcada, Fuertes, Gangolells, Casals, & Macarulla, 2013). Once a few of the larger firms had begun using and benefiting from a knowledge focused approach, mimetic institutional pressures influenced other industry firms to recognize the opportunity to address some of the commonly dealt with industry challenges, and as such, the perceptions of those industry challenges were likely redefined. Ideally, this pressure to adopt new approaches would ultimately lead to a lessening of some of the challenges.

As validated by the data analysis from Chapter IV, the institutional pressures to adopt knowledge management practices indirectly results in project benefits, but not before being mediated by the the numerous obstacles and related tools employed by organizations. The model shows the influence of the mimetic institution pressures on both obstacles to that adoption, and tools used by organizations to overcome knowledge management obstacles. These relationships indicate that by recognizing the challenges associated with knowledge management practice, and utilizing several knowledge management tools like email, small group meetings, training and development plans, and

intranets, organizations can realize increases in project benefits like producing excellent results and exceeding customer expectations.

Knowledge management obstacles were significant for many organizations, and at the top of that list were time and material resource barriers that prevented organizations from attempting to change their organizational practices and structures to be more conducive to knowledge management goals. Spending valuable time and money on a relatively intangible activity is difficult for construction organizations to do, even though nearly every organizational leader indicated that their organization recognized the value in knowledge management and felt that by not attending to it's potential, they were making regular mistakes and missing out on business opportunities. These barriers represent a significant factor in the communicative accomplishment of knowledge work puzzle, as it appears that many organizations are still apprehensive to make changes based on the risk associated with adopting new practices, even when they believe in the potential outcome.

Organizational culture was also included in the model to depict the significant influence that the construct has on a firm's ability to engage in knowledge management practice. Chapter III identified that usefulness of a learning-in-organizing culture for Constructors. The learning-in-organizing culture, which consisted of organizational values centered around developing talent, connecting the right expertise to the task at hand, and innovating their work practices to meet the needs of the customer and industry, meant that Constructors focused on creating relational communicative activities through systematic planning and problem solving processes. Organizational

culture then plays a large role in an organization's ability to engage various knowledge management tools, as was found to be the case in Zheng, Yang, & McLean's (2010) study, which found knowledge management to completely mediate the relationships between organizational culture and organizational effectiveness.

Moving towards the micro elements of the model, knowledge accomplishing episodes are the actual communicative *work* being done in the moment when organizational members are faced with a potential or current threat to their ability to move forward. The distinction between potential and current problems is an important one, as the model is attempting to highlight the difference between communicative knowledge work based on not just the level of determinacy, as indicated by Kuhn and Jackson (2008), but also by the problem's temporal nature. The findings of Chapter III demonstrated the prevalence of knowledge deployment over knowledge development. I observed much more requesting and transmitting of information and knowledge than teaching and improvising at Constructors. Based on well documented industry challenges and personal experience, I anticipated finding a tremendous amount of in-the-moment problem solving. Looking back at the findings and the data of Chapter III, it was apparent that the organizational structure and systemic processes that were in place at Constructors shifted the communication from something that sounded like reacting to unknown and unforeseen problems, to conversations about potential options and relevant information. Constructors had presented me with an organizational structure, culture, and strategy that was indeed developing knowledge accomplishing episodes that were relatively determinate, and in need of much less negotiation of situation framing

resources (identity, legitimacy, accountability, and embodiment). As a result, the knowledge accomplishing episodes that I observed and talked about with organizational members appeared uneventful.

These relatively low pressure knowledge accomplishing episodes were largely anticipatory. Anticipatory communication was focused on the planning and organizing in preparation of potential threats to Constructors ability to make forward progress on a project. Much of this action took place during the structured occasions, where the organization recognized the appropriate expertise that was needed to tackle the type of project that was being planned for. Planning and organizing involved much of the relational communicative knowledge management activities like asking questions and relying on mentors to help guide the planning process discussed in Chapter III.

The model highlights anticipatory inquiry as a useful communicative practice during this kind of knowledge accomplishing episode. By anticipatory inquiry, I'm referring to the inquisitive interactions among project members that help to highlight what each stakeholder sees as a potential threat, or opportunity to overcome a potential threat. During the planning phases of a project, Constructor's employees were regularly asking one another for opinions and information, or disseminating what they knew about a certain knowledge domain, in order to provide perspective and awareness. Take the conversation from Chapter III where an area lead and two operations coordinators were meeting with two representatives from a formwork company who would work with them on a highly custom public memorial project. The structured occasion meant that the two organizations were meeting to talk through some of their ideas and recognize what they

needed to be addressed in order to put together a successful bid. Anticipatory inquiry can be seen with the area lead asking for some input on general numbers for costs from the formwork representatives:

> Area Lead: We know you're not going to be able to get us a firm number, but if you can get a ballpark on what this will be…
>
> Formwork 2: We can figure out a unit cost on rolled whaler vs. custom whalers to help give you some options.

The area lead has asked about costs because he knows whatever approach they take, cost will be a significant variable in the bidding and construction process. He expressed to me previously that the project could either put them on the cover of a magazine or be a huge financial hit depending on how well they were able to come up with a system to address the unique design challenges. By framing his question to the formwork suppliers in terms of getting some rough estimates, he indicates that he understands there isn't a specific answer that can come from such an estimation. The formwork representative responds with the option of providing multiple numbers using two different approaches in an attempt to convey as much information as possible to Constructors in order to help them in the bidding process. Later on in the conversation, the first formwork representative also suggested that he knew of a relatively new formwork system that was being developed and used by a company out of Germany, which could potentially provide the kind of flexibility and durability that the project would require of its concrete forms. By promising to track down more information about prices and options, the formwork supply company was helping Constructors to develop a well-rounded plan to approach the bidding and construction process in a way that would meet the clients

needs as well be financially viable. This anticipatory knowledge accomplishing episode was addressing a future potential issue and consisted of a structured occasion, anticipatory inquiry, and knowledge deployment (i.e. information request and dissemination). This type of knowledge work has a few characteristics that I will highlight before discussing the reactive side of the model.

First, anticipatory communication appears to be more apparent when structured occasions are in place to promote and guide a systematic planning and organizing activity. These knowledge management systems, similar to what was seen at Constructors, essentially provides a framework to help organizational members recognize who needs to be communicating about the project at different points in the process. Without such a system, many of these conversations may no be given the necessary consideration. This is because the norm in the industry is to assign a project to a project lead and tell them to get it done in a certain amount of time, with very little opportunity to develop a plan or incorporate the known experts into the project phases.

The knowledge management systems and anticipatory knowledge accomplishing episodes also then rely on a semi-functional transactive memory system and relationship development in order to bring the relevant experts and voices to the planning and organizing process. The activity that constitutes the structured occasions requires that the individual who is leading the project take the time to recognize who can help them be the most successful. This means that they are aware of who knows what in their organization, or which suppliers and stakeholders may need to be brought into the loop. By engaging in the planning and organizing conversations, recognizing potential

problems, and engaging in anticipatory communication in an effort to curb those issues before they become a reality on the jobsite or later in the construction process, organizational members are strengthening their network of experts.

Other characteristics include seemingly endless options and tools, and relatively undefined obstacles. Given that these potential problems are just that, it's important to recognize that anticipatory communication can only prepare one for the foreseeable future. This is both an opportunity and a detriment. It is an opportunity in that there are any number of options and tools available to help address potential roadblocks, and like the new formwork system from Germany, one may not know of all of those options until engaging in conversations with others who might be able to provide a new perspective. Simultaneously, due to the novelty and fragmented nature of the the industry, unforeseeable problems will inevitably occur with each project. There is no sure way of knowing what threats one creates by choosing on option or tool over another in the planning and organizing phase. This also means that anticipatory communication requires previous experience and expertise.

Experience is needed when looking at a project and recognizing that something will likely be problematic when on site. Constructors knowledge management system required a field and project lead to develop a plan for a project before presenting that plan to the more experienced operations tier individuals for feedback and approval. This system appears to put the planning and organizing in the hands of relatively less experienced individuals, but considering the turnover meetings that took place when projects were assigned to specific field and project leads, major challenges were usually

highlighted for those individuals as opportunities to show the operations leads what the team was capable of coming up with. Using this approach, Constructors was able to draw upon the experience and knowledge of the operations tier individuals, while providing field and project leads the chance to come up with options for how to address those challenges on their own through the use of their expertise and that of their network. This simultaneously engaged the know-how of all project members while providing a sense of ownership among those who were responsible for much of the construction activity on a day-to-day basis.

The other form of knowledge accomplishing episodes are the reactive communication activities. These activities address immediate or past problems and attempt to create capacities for action. They do so by changing the circumstances of the situation or learning from that situation in a way that allows for future anticipation. Reactive communication knowledge accomplishing episodes can consist of review and record activities during structured occasions. The structured occasions system implemented by Constructors didn't complete the after-action-review process, and thus perhaps didn't constitute a complete system. Reviewing actions and recording lessons learned for future endeavors, or sharing learning through story-telling, are important aspects to the knowledge management process, and should not be ignored (Carrillo & Chinowski, 2006; Forcada, Fuertes, Gangolells, Casals, & Macarulla, 2013).

The reactive communication side of the knowledge accomplishing episode model also consists of retroactive sense-making. Organizational members or project stakeholders attempt to determine what factors lead up to the current problem in order to

understand how to create a capacity for action. Thus, this also involves in-situ problem solving, were the ability to move forward is paramount so that the project may stay on schedule and budget.

The kind of problem solving accomplished in the moment is different than that being done in an anticipatory manor, as it more often requires knowledge development instead of simple knowledge deployment. When something happens in the middle of a project that was unforeseen, it is much more likely to require what Kuhn and Jackson suggest to be knowledge instruction (i.e. "I'll teach you how to avoid this situation in the future and fix the current problem you're facing right now) or knowledge improvisation. These indeterminate situations require much more negotiation of the situation framing resources (identity, legitimacy, accountability, and embodiment).

For example, when one project lead was faced with anchor bolts that were preventing him from utilizing blankets to cover freshly poured foundations in order for them to cure properly, he brought the issue back to the office and engaged his network of experts to help him negotiation the appropriate course of action. The project had been planned to be completed during the summer season, and not the middle of winter, meaning that this situation had not be considered in anyone's anticipatory communication. During the knowledge accomplishing episode, several senior operations tier individuals worked with the project lead to determine whether the customer's representative was in fact correct in his concern for proceeding at below-freezing temperatures. They negotiated legitimacy and identity as they talked about who had the power to make that call, and the expertise to know whether it was going to provide a

strong enough footing. Their embodiment was negotiated as each described how to work in the dirt trenches to keep the surrounding soil and reinforcing steel at an appropriate temperature for the pouring schedule to stay on track. And, they negotiated who would be held accountable for the bill if their added labor and material costs for extra cold-weather work were to exceed their originally agreed upon price for their portion of the project work. This form of reactive communication also has some characteristics that are slightly different from that of the anticipatory type.

This reactive from of knowledge accomplishing episodes and communication also helps to develop and sustain transactive memory systems within the organization and larger stakeholder network. Problem solving in the moment requires a clear understanding of the task-expertise-person (TEP) units. If that understanding isn't fully developed, having to solve a problem quickly and effectively will require filling in the unknowns. Finding out who, for example, can help you rush a change-order through the system to get reimbursed for additional work when extreme weather has delayed a project will help complete the task-expertise-person units needed for a robust transactive memory system. Additionally, responding to a current threat or making sense of a past problem means that one must deal with the reality of the situation, which means that there are defined obstacles and likely only a limited number of tools and outcomes that be realized. Previous decisions and actions cannot be undone, and one must deal with the situation as it is presented.

Lastly, reactive knowledge accomplishing episodes are rife with opportunities to develop experience and learning. Creating capacity for action in the moment leads to a

new understanding. Perhaps a problem that has never been encountered before is now familiar, or a familiar issue is solved in a novel way, or in retrospect, the organization is better prepared for the next similar challenge. Either way, this new learning experience, as indicated in the model, ultimately drives a change in knowing and discursive practice (Orlikowksi, 2002), as it shapes the way that one approaches the next problem, whether anticipatorily or reactively. The cycle of anticipatory and reactive knowledge accomplishment creates greater knowledgeability within the organization and among its network of stakeholders. As such, project benefits are realized, or realized to a greater degree than before, as a better product is achieved for the customer and new knowledge has been added to the organizational repertoire. Organizational culture, then too, becomes a beneficiary of these knowledge accomplishing episodes. As organizational members learn and gain experience, their know-how influences the knowledge sharing and developing culture. Changes in knowing and discursive practice also enhances knowledge management systems and tools, as organizational members are more capable of engaging in knowledge deployment or development.

Practical Implications

Organizations need to understand where their unique knowledge domains lie, and consciously establish communicative knowledge management practices like structured occasions to help connect them. Knowledge management tool use should help improve organizational outcomes like project benefits, and potentially others (e.g. innovative capacities, intellectual capital, and competitive advantage). One of the communicative accomplishing tools that organizations like Constructors could rely on as they develop

more dispersed, and relatively flat organizational structures, are versions of transactive memory systems that rely on a confluence of well articulated project data and information communication technologies, along with the spread of structural organizational practices and cultural shifts that support the building of social capital among organizational members. Social capital is a fundamental building block used among informal knowledge networks in the construction industry (Styhre, 2009), where the value lies in each organizational member's connection to others from which they can draw needed inspiration, information, or assistance in knowledge development.

Paying attention to the organization's network of communication and information flows is an essential part of understanding how an organization can best utilize the intellectual capital among its ranks. For example, developing a dispersed network around various organizational structures other than business units, for example communities of practice or building type (e.g. X, Y, Z in Constructors cases), may help to create important connections among dispersed business units and project teams as organizational members are given opportunities to create new connections with others who share the similar knowledge interests or expertise, or can simultaneously take advantage of the heterogeneity of knowledge sources in different regions and markets. Information communication technologies like email and document management software can then become appropriate supplementary tools to help increase coordination and communication opportunities through more rich communication channels.

Construction organizations should consider the conscious knowledge management tools they enact, their effectiveness, and the continuous documentation and

learning from organizational and project outcomes to continue to hone their knowledge management best practices (Kale & Karaman, 2012). Completing the project learning life-cycle by recording lessons learned both during and after the completion of a project may help to inform further conversations on the problems that were addressed and the knowledge episodes that took place during project planning, implementation, and completion.

Lastly, it appears that construction organizations may be able to overcome some of the time and material hurdles associated with knowledge management adoption by enacting more informal opportunities for the organizational network to learn more about who knows what. Formalizing all knowledge management practices can become too much of a burden and turns opportunities into chores. For example, one member at Constructors talked about a formalized presentation process where organizational members would present new or vital information about an issue related to the organization's work on a monthly basis. He recalled how that practice eventually died off because of a lack of support, interests, and time.

Using a similar forum idea, organizational members could post a small amount of information in the form of an article, a question, a story, or a picture of something related to what they have been working on, to help others in the organization see and read about what's happening on projects, in the organization, or in the industry. Perhaps something as simple as highlighting expertise of individuals of project teams in the company-wide newsletter could support further know-how recognition. Promoting opportunities for a story-telling culture industry to tell stories and share ideas more

conveniently and informally will only make strides in improving the density and usefulness of the knowledge network at hand. Creating innovative knowledge management processes or opportunities that meet both the needs and constraints of the organization is a challenge that needs substantial consideration.

Future Research and Propositions

Considering the results of this research project, several opportunities for future research can be imagined. To support these opportunities, and to provide structure to a continued research agenda that is interested in furthering the capabilities of construction firms, propositions accompany some of the subsequent future research agenda ideas.

First, how could organizations extend the model provided by the subject matter experts at Constructors to other areas of the organization? Constructors safety subject matter experts (SME) constituted a formalized community of practice combined with many of the properties of a transactive memory system. By creating a small group of people who were responsible for safety procedures and training and education, Constructors established communities of practice at multiple locations who mimicked and co-created safety best practices based on their organizational experience and industry know-how. In addition, subject matter experts were assigned a particular knowledge domain within their community of practice that formally placed the responsibility for particular safety protocols and knowledge on certain easily identifiable people on each jobsite. By delineating the knowledge domains necessary to safely operate on any construction site, and creating an easy visual identification process to help other organizational members quickly identify the knowledge/safety experts, each

business unit had a functional transactive memory system in place to ensure that no one person was responsible for being the safety expert. *Proposition 1***:** Establishing more clearly defined SMEs for particular niche knowledge domains in the construction industry may help scale a TMS more effectively to the organizational level, and perhaps to the inter-organizational level to help address the compounding issues associated with completing a construction project with many other skilled trades simultaneously.

If firms rely on largely tacit, sticky, socially constructed and mutually defined knowledge, then how do they ensure they're able to maintain the knowledge among their individuals, teams, and business units? In other words, if knowledge and knowing is a social phenomenon that relies on our ability to communicate what is known in any given situation among a group of stakeholders, then in what ways should organizations be protecting their human capital? A resource-based view of the firm considers individuals and teams to be their most valuable organizational resource. It is among and between these individuals and teams where knowing is found to create capacities for action. As a result, firms should be dedicating significant tangible resources towards the acquisition and retention of those human resources.

One way to promote such retention is through the increased focus on organizational culture that helps to determine employee satisfaction and reduces intentions to leave the organization or industry. *Proposition 2***:** The cultural learning-in-organizing approach should discourage organizational turnover, thus helping to curtail knowledge loss through employee attrition. This proposition is based on two similar observations. First, construction organizations may rely more on the informal network

and individual social capital in order to communicate knowledge and solve problems in the firm (Styhre, 2009) than formal knowledge management systems. And second, Feeley, Moon, Kozey and Slowe (2010) found evidence that organizational members are less susceptible to turnover as they experience higher levels of network centrality, if that centrality also comes with social support. Therefore, if construction firms encourage opportunities for organizational members to build social capital, this should inherently increase their network centrality as they engage with more colleagues both inside and out of their organizations. This increased level of social capital and centrality, accompanied by higher levels of social support should promote lower levels of voluntary employee turnover. As such, the organization should be able to attract significant talent (those with higher social support are also more satisfied with their work) and keep that talent around longer, enhancing the firm's ability to perform.

Lastly, why are some knowledge management tools and practices more effective than others? This research was able to better understand why some organizations decided to adopt knowledge management practice, but that is just the start. Further investigations could help uncover underlying institutional pressures that lead to particular kinds of knowledge management system adoptions, and how organizations determine the right mix of social and technological tools and system configurations. One way of doing this could involve formalizing the anticipatory and reactive communication techniques discussed in Figure 2 to help better understand the interdependence between these two forms of knowledge accomplishing episodes and how they specifically interact with the tools and barriers highlights in the data from Chapter IV. Also, comparing data

from organizations like Constructors with that of others who have adapted innovative systems may be a helpful approach to highlighting some of the useful practices within the industry, as one of the obstacles to adoption of new knowledge management practices was identified as being a lack of proven methods.

REFERENCES

Acker, J. (2005). *Class questions: Feminist answers*. Lanham, MD: Rowman & Littlefield.

Adenfelt, M. (2010). Exploring the performance of transnational projects: Shared knowledge, coordination and communication. *International Journal of Project Management, 28*, 529-538.

Al-Ghassani, A. M., Anumba, C. J., Carrillo, P. M., & Robinson, H. S. (2005). Tools and techniques for knowledge management. In C. J. Anumba, C. Egbu & P. Carrillo (Eds.), *Knowledge management in construction* (pp. 83-102). Oxford: UK: Blackwell Publishing.

Alvesson, M. (2001). Knowledge work: Ambiguity, image and identity. *Human Relations, 54*, 863-886.

American Society of Civil Engineers. (2013). About America's Infrastructure. Retrieved from http://www.infrastructurereportcard.org/executive-summary/

Amin, A., & Cohendet, P. (2004). *Architectures of knowledge: Firms, capabilities and communities*. Oxford University Press.

Anumba, C. J., Egbu, C., & Carrillo, P. (2008). *Knowledge management in construction*. Malden, MA: Blackwell.

Barlow, J. (2000). Innovation and learning in complex offshore construction projects. *Research Policy, 29*, 973-989.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*, 99-120.

Bartholomew, D. (2009). *Building on knowledge: Developing expertise, creativity and intellectual capital in the construction professions.* New York: Taylor & Francis.

Bollinger, A. S., & Smith, R. D. (2001). Managing organizational knowledge as a strategic asset. *Journal of knowledge management, 5,* 8-18.

Brandon, D. P., & Hollingshead, A. B. (2004). Transactive memory systems in organizations: Matching tasks, expertise, and people. *Organization Science, 15,* 633-644.

Bresnen, M., Edelman, L., Newell, S., Scarbrough, H., & Swan, J. (2003). Social practices and the management of knowledge in project environments. *International Journal of Project Management, 21,* 157-166.

Bresnen, M., Edelman, L., Newell, S., Scarbrough, H., & Swan, J. (2005). Exploring social capital in the construction firm. *Building Research & Information, 33(3),* 235-244.

Brown, J. S., & Duguid, P. (2001). Knowledge and organization: A social-practice perspective. *Organization Science, 12(2),* 198-213.

Brown, J. S., & Duguid, P. (2002). *The social life of information.* Boston: Harvard Business Press.

Canary, H. E., & McPhee, R. D. (2011). Toward a communicative perspective on organizational knowledge. In H. E. Canary, & R. D. McPhee (Eds.), *Communication and organizational knowledge: Contemporary issues for theory and practice* (pp. 1-14). New York: Routledge.

Carlile, P. R. (2002). A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization Science, 13,* 442-455.

Carrillo, P. (2004). Managing knowledge: lessons from the oil and gas sector. *Construction Management and Economics, 22(6),* 631-642.

Carrillo, P., & Chinowsky, P. (2006). Exploiting knowledge management: The engineering and construction perspective. *Journal of Management in Engineering, 22,* 2-10.

Carrillo, P. M., Robinson, H., Al-Ghassani, A., & Anumba, C. J. (2004). Knowledge management in UK construction: Strategies, resources and barriers. *Project Management Journal, 35(1),* 46-56.

Census Bureau. (2015). *Value of construction put in place at a glance: September 2015.* Retrieved from http://www.census.gov/construction/c30/c30index.html

Cetina, K. K. (1997). Sociality with objects: Social relations in postsocial knowledge societies. *Theory, Culture & Society, 14(4),* 1-30.

Chen, C., & Huang. (2009). Strategic human resource practices and innovation performance: The mediating role of knowledge management capacity. *Journal of Business Research, 62(1),* 104-114.

Chia, R. (1998). From complexity science to complex thinking: Organization as simple location. *Organization, 5,* 341-369.

Chidlow, A., Ghauri, P. N., Yeniyurt, S., & Cavusgil, S. T. (2015). Establishing rigor in mail-survey procedures in international business research. *Journal of World Business, 50,* 26-35.

Conrad, C. R. (2011). *Organizational rhetoric: Strategies of resistance and domination* Malden, MA: Polity.

Cook, S. D., & Yanow, D. (1993). Culture and organizational learning. *Journal of Management Inquiry, 2(4),* 373-390.

Cooren, F., Kuhn, T., Cornelissen, J. P., & Clark, T. (2011). Introduction to the special issue: Communication, organizing and organization: An overview. *Organization Studies, 32,* 1-22.

Davenport T. H., & Prusak L. (1998) *Working knowledge: How organizations manage what they know.* Boston: Harvard Business School Press.

Dillman, D.A. (2000). *Mail and internet surveys: The tailored design method* (2nd ed.). New York: Wiley & Sons.

Drejer, I., & Vinding, A. L. (2006). Organisation, 'anchoring'of knowledge, and innovative activity in construction. *Construction Management and Economics, 24,* 921-931.

Dubois, A., & Gadde, L. (2002). The construction industry as a loosely coupled system: Implications for productivity and innovation. *Construction Management & Economics, 20,* 621-631.

Eccles, R. G. (1981). Bureaucratic versus craft administration: The relationship of market structure to the construction firm. *Administrative Science Quarterly, 26,* 449-469.

Egbu, C. O. (2004). Managing knowledge and intellectual capital for improved organizational innovations in the construction industry: an examination of critical

success factors. *Engineering, Construction and Architectural Management, 11(5),* 301-315.

Emmitt, S., & Gorse, C. A. (2003). *Construction communication.* Oxford, U.K: Blackwell.

Emmitt, S., & Gorse, C. A. (2006). *Communication in construction teams.* New York: Routledge.

Faraj, S., & Sproull, L. (2000). Coordinating expertise in software development teams. *Management Science, 46(12),* 1554-1568.

Feeley, T. H., Moon, S. I., Kozey, R. S., & Slowe, A. S. (2010). An erosion model of employee turnover based on network centrality. *Journal of Applied Communication Research, 38(2),* 167-188.

Flanagin, A. J. (2000). Social pressures on organizational website adoption. *Human Communication Research, 26,* 618-646.

Fong, P. S. (2005). Building a knowledge sharing culture in construction project teams. In C. J. Anumba, C. O. Egbu, & P. M. Carrillo, (Eds*.), Knowledge Management in Construction* (pp. 195-212). Oxford: Blackwell.

Fong, S. W. and Wong, K. (2005). Capturing and reusing building maintenance knowledge: A socio-technical perspective. In: A.S. Kazi, (Ed.), *Knowledge management in the construction industry: A socio-technical perspective* (pp. 67-89). London: Idea Group Publishing.

Forcada, N., Fuertes, A., Gangolells, M., Casals, M., & Macarulla, M. (2013). Knowledge management perceptions in construction and design companies. *Automation in Construction, 29,* 83-91.

Frazier, P. A., Tix, A. P., & Barron, K. E. (2004). Testing moderator and mediator effects in counseling psychology research. *Journal of Counseling Psychology, 51,* 115.

Fu, N. (2014). The role of relational resources in the knowledge management capability and innovation of professional service firms. *Human Relations, 68,* 731–764.

Gherardi, S., & Nicolini, D. (2002). Learning the trade: A culture of safety in practice. *Organization, 9(2),* 191-223.

Global Construction Perspectives & Oxford Economics. (2013*). Global Construction 2025.* Retrieved from http://www.globalconstruction2025.com/worldwide/

Gupta, N., & Hollingshead, A. B. (2010). Differentiated versus integrated transactive memory effectiveness: It depends on the task. *Group Dynamics: Theory, Research, and Practice, 14(4),* 384.

Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs, 76(4),* 408-420.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York: Guilford Press.

Hofstede, G. (1980). Culture and organizations. *International Studies of Management & Organization, 10*(4), 15-41.

Hollingshead, A. B. (1998). Communication, learning, and retrieval in transactive memory systems. *Journal of Experimental Social Psychology, 34*(5), 423-442.

Huang, M., Barbour, J., Su, C., & Contractor, N. (2013). Why do group members provide information to digital knowledge repositories? A multilevel application of transactive memory theory. *Journal of the American Society for Information Science and Technology, 64*, 540-557.

Jackson, P., & Klobas, J. (2008). Transactive memory systems in organizations: Implications for knowledge directories. *Decision Support Systems, 44,* 409-424.

Jackson, M. H., & Willimson, J. (2011). Challenges of implementing systems for knowledge management. In H. E. Canary, & R. D. McPhee (Eds.), *Communication and organizational knowledge: Contemporary issues for theory and practice* (pp. 53-68). New York: Taylor & Francis.

Iacobucci, D., Saldanha, N., & Deng, X. (2007). A meditation on mediation: Evidence that structural equations models perform better than regressions. *Journal of Consumer Psychology, 17*, 139-153.

Javernick-Will, A. N., & Scott, W. R. (2010). Who needs to know what? Institutional knowledge and global projects. *Journal of Construction Engineering and Management, 136,* 546-557.

Kale, S., & Karaman, A. E. (2012). Benchmarking the knowledge management practices of construction firms. *Journal of Civil Engineering and Management, 18*, 335-344.

Kanapeckiene, L., Kaklauskas, A., Zavadskas, E. K., & Seniut, M. (2010). Integrated knowledge management model and system for construction projects. *Engineering Applications of Artificial Intelligence, 23*, 1200-1215.

Kandan, D. (2014). *Asia Construction Outlook*. Retrieved from http://www.aecom.com/deployedfiles/Internet/Geographies/Asia/Downloads/Asia%20Construction%20Outlook_2014.pdf

Kazi, A. S. (2005). *Knowledge management in the construction industry: A socio-technical perspective*. London: Idea Group Publishing.

Kuhn, T., & Jackson, M. H. (2008). Accomplishing knowledge: A framework for investigating knowing in organizations. *Management Communication Quarterly, 21,* 454-485.

Lewis, L. (2012). Becoming useful: Using engaged scholarship as a means to move NPO scholarship forward. *Management Communication Quarterly, 26*, 186-192.

Lin, Y., & Lee, H. (2012). Developing project communities of practice-based knowledge management system in construction. *Automation in Construction, 22*, 422-432.

Lindlof, T. R., & Taylor, B. C. (2010). *Qualitative communication research methods*. Thousand Oaks, CA: Sage.

McDermott, R., & O'Dell, C. (2001). Overcoming cultural barriers to sharing knowledge. *Journal of knowledge management*, *5*, 76-85.

Messner, J. (2003, March). An architecture for knowledge management in the AEC industry. In Proc. of the 2003 ASCE Construction Research Congress. Honolulu, HI.

Orlikowski, W. J. (2002). Knowing in practice: Enacting a collective capability in distributed organizing. *Organization Science*, *13*, 249-273.

Peltokorpi, V. (2014). Transactive memory system coordination mechanisms in organizations an exploratory case study. *Group & Organization Management, 39*, 444-471.

Peltokorpi, V., & Manka, M. L. (2008). Antecedents and the performance outcome of transactive memory in daycare work groups. *European psychologist, 13,* 103-113.

Pickering, A. (2010). *The mangle of practice: Time, agency, and science*. Chicago: University of Chicago Press.

Polanyi, M. (1997). Tacit knowledge. In L. Prusak (Ed.), *Knowledge in organizations*, (pp. 135-146). Boston: Butterworth-Heinmann.

Powell, W. W., & Snellman, K. (2004). The knowledge economy. *Annual Review of Sociology, 30*, 199-220.

Quintas, P. (2005). The nature and dimensions of knowledge management. In C. J. Anumba, C. Egbu & P. Carrillo (Eds.), *Knowledge management in construction* (pp. 10-30). Oxford: Blackwell.

Ren, Y., & Argote, L. (2011). Transactive memory systems 1985–2010: An integrative framework of key dimensions, antecedents, and consequences. *The Academy of Management Annals, 5*, 189-229.

Ren, Y., Carley, K. M., & Argote, L. (2006). The contingent effects of transactive memory: When is it more beneficial to know what others know? *Management Science, 52*, 671-682.

Rogers, E. M. (2010). *Diffusion of innovations*. New York: Simon and Schuster.

Rooke, J., & Clark, L. (2005). Learning, knowledge and authority on site: A case study of safety practice. *Building Research & Information, 33*, 561-570.

Schatzki, T. R. (2010). *Site of the social: A philosophical account of the constitution of social life and change*. University Park, PA: Penn State Press.

Schatzki, T. R., Knorr-Cetina, K., & von Savigny, E. (2001). *The practice turn in contemporary theory*. New York: Routledge.

Senge, P. (2000). *The art and practice of the learning organization*. New York: Doubleday.

Sennett, R. (2008). *The craftsman*. New Haven, CT: Yale University Press.

Sole, D., & Edmondson, A. (2002). Situated knowledge and learning in dispersed teams. *British Journal of Management, 13*, S17-S34.

Spender, J. C. (2005). Review article: An essay of the state of knowledge management. *Prometheus, 23*, 101-116.

Stacey, R. D. (2010). *Complexity and organizational reality. Uncertainty and to the Need Rethink management after the collapse of investment capitalism*. New York: Routledge.

Storey, J., & Barnett, E. (2000). Knowledge management initiatives: learning from failure. *Journal of Knowledge Management, 4*, 145-156.

Styhre, A. (2008). The role of social capital in knowledge sharing: The case of a specialist rock construction company. *Construction Management and Economics, 26*, 941-951.

Styhre, A. (2009). *Managing knowledge in the construction industry*. New York: Routledge.

Styhre, A., Josephson, P., & Knauseder, I. (2004). Learning capabilities in organizational networks: Case studies of six construction projects. *Construction Management and Economics, 22*, 957-966.

Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal, 17*, 27-43.

Thomas, J. B., Sussman, S. W., & Henderson, J. C. (2001). Understanding "strategic learning": Linking organizational learning, knowledge management, and sensemaking. *Organization Science, 12*, 331-345.

Tsoukas, H., & Vladimirou, E. (2001). What is organizational knowledge? *Journal of Management Studies, 38*, 973-993.

Tulacz, G. (2014). *ENR: The top 400 contractors*. Retrieved from Engineering News-Record: http://enr.construction.com/toplists/Top-Contractors/001-100.asp

U.S. Bureau of Labor Statistics. (2015). *Revisions to the 2013 census of fatal occupational injuries* (CFOI) counts. Retrieved from http://www.bls.gov/iif/oshwc/cfoi/cfoi_revised13.pdf

U.S. Department of Commerce, Bureau of Economic Analysis. (2015). *Gross domestic*

product by industry data. Retrieved from http://www.bea.gov/industry/gdpbyind_data.htm

U.S. Department of Commerce, United States Census Bureau. (2015). *Value of construction put in place: Seasonally adjusted annual rate*. Retrieved from http://www.census.gov/construction/c30/c30index.html

Von Krogh, G., Nonaka, I., & Aben, M. (2001). Making the most of your company's knowledge: A strategic framework. *Long Range Planning, 34*, 421-439.

Wegner, D. M. (1987). Transactive memory: A contemporary analysis of the group mind. In B. Mullen, & G. R. Goethals (Eds.) *Theories of group behavior* (pp. 185-208). New York: Springer.

Wegner, D. M. (1995). A computer network model of human transactive memory. *Social Cognition, 13*, 319-339.

Wegner, D. M., Erber, R., & Raymond, P. (1991). Transactive memory in close relationships. *Journal of Personality and Social Psychology, 61*, 923.

Yang, L., Chen, J., & Wang, H. (2012). Assessing impacts of information technology on project success through knowledge management practice. *Automation in Construction, 22*, 182-191.

Zerjav, V., Hartmann, T., & Javernick-Will, A. (2011). Internal governance of design and engineering: The case of the multinational firm. *Journal of Construction Engineering and Management, 138*, 135-143.

Zhang, Z. X., Hempel, P. S., Han, Y. L., & Tjosvold, D. (2007). Transactive memory system links work team characteristics and performance. *Journal of Applied Psychology, 92(6)*, 1722.

Zheng, W., Yang, B., & McLean, G. N. (2010). Linking organizational culture, structure, and organizational effectiveness: Mediating role of knowledge management. *Journal of Business Research, 63*, 763-771.

Zorn, T. E., Flanagin, A. J., & Shoham, M. D. (2011). Institutional and noninstitutional influences on information and communication technology adoption and use among nonprofit organizations. *Human Communication Research, 37*, 1-33.

Zorn, T. E., & Taylor, J. R. (2004). Knowledge management and/as organizational communication. In D. Tourish, & O. Hargie (Eds.), *Key issues in organizational communication* (pp. 96-112). London: Routledge.

APPENDIX A

Semi-Structured Interview Protocol

The interviewer should use the following as a rough guide for asking questions. As is the nature of qualitative research interviews, these questions serve as a guide for the tenor of the research conversations. If follow up questions are asked that are not on this list, they will be very similar to these questions. We have included language that reflects the sorts of follow up questions that are likely.

1) In general, on the job, how do you communicate what you know to others?
   a) Is this different than how others communicate what they know to you?
   b) Can you remember a time when you needed to communicate your knowledge or expertise? How did you do it?
   c) What do you think is unique about your organization and/or your approach to coordinating or managing knowledge?
   d) How do you know what others know?

2) Who do you communicate with on projects? What do you talk about?
   a) How and how often do you and other project members communicate?
   b) What responsibilities do you have during a project?
   c) What are the different expertise areas needed during a project?
   d) What happens when someone leaves the community? How does the team adjust?

3) What works well when managing a project?
   a) Is there an example?
   b) How did it start? Then what happened? Who was involved? (Communicative episode.)

4) What challenges exist during or in between projects?
   a) Is there an example?
   b) For example, what do you do when someone leaves who knows a lot about the work you are doing?
   c) How do you share the information/know-how you need to given the short time you have to get work done?
   d) How did it start? Then what happened? Who was involved? (Communicative episode.)

5) Reflecting on those situations, how did you deal with those challenges?
   a) What has made the communication involved effective/ineffective?
   b) How did you pick out the most important aspects of your knowledge to communicate?
   c) How did you mark them as important in your communication?
   d) What does ideal communication in project based organizations look like?

APPENDIX B

Survey Instrument

Managing Knowledge in the Construction Industry Survey

This questionnaire is designed to assess the level of awareness, use of, and benefits derived from knowledge management by the U.S. construction industry. The survey is **not** intended to capture any commercially sensitive information. Nevertheless, all information will be treated as strictly confidential. As you respond to the questions, please answer with a check mark (✔) or ☒. **As you answer keep these ideas in mind:**

Knowledge management (KM) is a conscious attempt to utilize skills and know-how as organizational resources in order to maintain or improve a firm's competitive advantage, and can consist of a variety of tools, practices, activities, procedures and systems. *Knowledge Management Systems (KMS)* are any structured practices that are implemented throughout the organization in order to effectively and efficiently manage knowledge, technological or otherwise.

Q1. What % of employees leave your organization each year typically (retirement, turnover, downsizing)? _____

Q2a. Are you personally aware of any situation in your organization in which costly errors or mistakes were made because of insufficient knowledge? Yes ☐ No ☐ **Q2b**. If yes, why?

	Loss of knowledge of vital importance		Insufficient knowledge about competitors		Knowledge unavailable when needed
	Insufficient knowledge about customers		Employees cannot interpret or use available information		Repetition of previous errors
	Insufficient knowledge about processes		Other:		

Q3. To what degree does your organization value knowledge as a strategic asset?

Not at all Valuable	Somewhat Valuable	Valuable	Quite Valuable	Very Valuable

Q4. Please evaluate the contributions knowledge management can offer your organization?

Contribution	Not at all Beneficial	Somewhat Beneficial	Beneficial	Quite Beneficial	Very Beneficial
Decision-making improvement					
Efficiency improvement					
Group work improvement					
Product/service improvement					
Cost cuts					
Flexibility improvement					
Delivery time reduction					
Customers and suppliers' relation improvement					
Quality improvement					
Employees experience exchange					

Q5a. Are there situations in which the knowledge acquired by only one or two employees would be useful for a higher number of employees? Yes ☐ No ☐

Q5b. If yes, how useful?	Not Very Useful	Somewhat Useful	Useful	Quite Useful	Very Useful
Q5c. If yes, how often?	Not Very Often	Somewhat Often	Often	Quite Often	Very Often

Q6a. Do you believe you may be currently missing out on business opportunities by failing to successfully exploit available knowledge? Yes ☐ No ☐ If yes, how significant are those business opportunities to your organization?

Q6a. If yes, how significant?	Not at all Significant	Somewhat Significant	Significant	Quite Significant	Very Significant

Q7a. Is there currently any kind of knowledge management system (**KMS**) available in your organization?

	Yes. There is a KMS available. If Yes, what year was the KMS implemented? _____
	There is no KMS available at the moment. But we are working on one.
	No, but we are considering the possibility.
	We have no KMS and are not planning to have one.

Q7b. If you organization *is* developing a KMS, or has one in place, in what business area is it being implemented?

_____

Q8. Who is responsible for creating, implementing, and overseeing KM activities in your organization?

	Top Management		Department managers		Specific knowledge management officer/position
Other:					

Q9. What are the obstacles to developing KMSs on a scale of from 1 to 5?	**Insignificant Obstacle -1**	**2**	**3**	**4**	**Significant Obstacle - 5**
Change of mentality needed to use these systems					
Change of organizational culture needed to use these systems					
Time needed and high cost of implementing a KMS					
Lack of proved methods for carrying out KM during projects					
Low involvement of top management					

Q9 (cont). What are the obstacles to developing KMSs on a scale of from 1 to 5?	Insignificant Obstacle -1	2	3	4	Significant Obstacle - 5
Low involvement of employees					
Emphasis on an individual level rather than a team level					
People's fear of sharing what they know					
Lack of an incentive system					
Layout of work spaces					
Lack of the technological infrastructure needed for its implementation					
Lack of training					
Information systems dispersed in different technological media					
The concept is unknown					
Turnover					
Other:					

Q10. How effective are these tools within your organization for knowledge management purposes?	Not Used	Very Ineffective	Somewhat Effective	Effective	Quite Effective	Very Effective
Email						
Intranet						
Internet						
Communities of practice						
Video conferencing						
Databases						
Decision making tools						
Small group meetings (2-4 people)						
Training and education plans						
Consultancy						
Monitoring of project/services by clients						
Talent acquisition						

Q11. Please think of your company's most recent major project. Indicate how much you agree with each statement, where 1 is strongly disagree and 5 is strongly agree?	1	2	3	4	5
The schedule for each phase of the project was as planned.					
The cost objectives were met for the project.					
The facilities were built based on the owner's requirements.					
The project complied with all applicable regulations.					
New knowledge was generated on the project.					
All project assignments were proceeding as planned.					
The budget for each phase of the project was as planned.					
The quality objectives were achieved for the project.					
The recordable accident rate for the project was low.					
The project's overall benefits exceeded owner's expectations.					
The project was delivered ahead of schedule.					
The deliverables complied with contractual requirements.					
The recordable injury rate for the project was low.					
The projects produced excellent results.					

Q12. In general, to what degree do you agree or disagree with these statements, where 1 is strongly disagree and 5 is strongly agree?	1	2	3	4	5
There is tough competition in our industry based on the quality of our services.					
Information on organizations that provide similar services is considered important for decisions.					
Normally, organizations that do what we do, *do not* use knowledge management practices.					
Typically, organizations in our field rely heavily on information communication technologies.					
Our organization actively keeps abreast of new and innovative practices used by other organizations in our industry.					
Organizations such as ours rely heavily on information communication technologies these days.					
Typically, organizations in our field rely heavily on knowledge management practices.					
Normally, organizations that do what we do use information communication technologies.					
There is tough competition in our sector for funding and support.					
Organizations such as ours rely heavily on knowledge management practices these days.					
We monitor the moves of "competitors" very closely.					
Our organization must remain competitive with others in our field.					

Demographic Questions What is your title at the organization? _____

How long have you worked for your organization (closest in years)? _____In your current position? _____

About how many employees work in your organization? _____

What is your gender? _____☐Prefer not to answer

What is your age? _____☐Prefer not to answer

What is the highest level of education you have completed?_____☐Prefer not to answer

Are you of Hispanic, Latino, or Spanish origin? _____☐Prefer not to answer

How would you describe your race?_____☐Prefer not to answer